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MODERN BUILDING SUPERINTENDENCE AND THE WRITING OF SPECIFICATIONS

DAVID B. EMERSON

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MODERN
BUILDING SUPERINTENDENCE
AND THE
WRITING OF SPECIFICATIONS

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BY
DAVID B. EMERSON

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PREFACE

THE chapters of this book were originally written as a series of magazine articles. The purpose in writing them was to aid the younger members of the profession. Nothing new or original is claimed, but an attempt has been made to give some information which is not generally found in books on construction. Although written for the use of students and juniors, it is hoped that in some ways it may be of some little value to the older members of the profession in their work. The author wishes to express his appreciation to Mr. Louis R. Holske, Mr. E. L. Verveer, Mr. George Hewett, Mr. Floyd M. Chapman, and a number of others, for their advice and assistance. Also to give proper credit to

456121

Austin B. Byrne's "Inspection of Materials and Workmanship Employed in Construction," Frank B. Gilbreth's "Bricklaying System," and other works, for material used from them.

DAVID B. EMERSON.

CONTENTS

I

MODERN BUILDING SUPERINTENDENCE

CHAPTER		PAGE
I.	Introductory	3
II.	Excavation, Foundations, Concrete	9
III.	Structural Steel and Floor Arches	26
IV.	Cut Stone, Ornamental Terra-Cotta, and Brickwork	37
V.	Plastering, Marble and Tile Work	53
VI.	Sheet-Metal Work, Ornamental Iron and Carpenter Work . . .	66
VII.	Plumbing and Drainage	83
VIII.	Electric Wiring and Elevators .	99
IX.	Bank Vaults and Fixtures	121
X.	Heating and Vacuum Cleaners .	133
XI.	Installing of Fire Protection and Fitting Up Turkish Bath	155
XII.	A Short Talk on Building Construction	170

II

THE WRITING OF SPECIFICATIONS

CHAPTER		PAGE
I.	CARE AND SPECIAL KNOWLEDGE ESSENTIAL. THE IMPORTANCE OF DEFINITENESS. THERE SHOULD BE NO ROOM FOR DOUBT	183
II.	WRITING SPECIFICATIONS FOR A SMALL HOUSE	191
III.	DANGER-SIGNALS FOR SPECIFICATION WRITERS	213
IV.	WORKABLE DRAWINGS	227
V.	DRAUGHTSMEN AND READING	235
	APPENDIX	241

PART I

Modern Building Superintendence

UNIV. OF CALIFORNIA

CHAPTER I

INTRODUCTORY

NEARLY forty years have elapsed since the late Professor Theodore M. Clark wrote his very instructive and interesting work on building superintendence. Those years have been very fruitful ones, producing many new materials and methods in building construction, so that Professor Clark's work is now very much out of date. Tall buildings, skeleton construction, steel beams, reinforced concrete, American Portland cement, membrane waterproofing, open plumbing, electric lighting, and vacuum cleaning systems have all been invented since that time, or were then in a nascent stage.

With all of these and many other new developments have naturally come many new methods of construction suited to the new materials. So it is not the intention on the part of the author of this book

to throw any discredit whatsoever upon Professor Clark's work, but rather to write as Clark might have written had his work been done in 1919 instead of in the early eighties.

The building of which we propose to follow the construction will be a large modern office-building, to be built in a thriving city of 250,000 population, by the local multimillionaire, who wishes to perpetuate his name and fame in the community where he has amassed his wealth, also to have a good paying investment. The size of the building will be about 150 feet by 200 feet, twenty stories high, three sides will face upon streets.

As the building is to be retained as a permanent investment, it will be constructed in the best manner possible, equal in every particular to the best class of office-buildings in New York or Chicago. The first floor will provide quarters for a bank and trust company, of which the owner is president and a principal stockholder. The remainder of the first floor will be used as

brokers' offices. Part of the basement will be occupied by the safe-deposit department of the bank, and the remainder will be fitted up as a high-class barber shop and an up-to-date Turkish bath establishment, equipped with a small swimming-pool. The heating apparatus, all pumps and machinery will be located in the sub-basement, which will be under only a part of the building.

The upper stories will be devoted entirely to rented offices. The building will be of first-class fireproof construction. The lower three stories will be faced with Indiana oolitic limestone, with a base course of granite. The basement and sub-basement walls, rear wall, and the backing up of all stonework up to the level of the second floor, will be of brick, above that the backing of all brick, stone, and terra-cotta will be of hollow tile, eight inches thick, with header tile for bonding to facing. Walls above third story faced with brick, window-sills, lintels, belt courses, cornice and other trim of terra-cotta.

Floor-slabs will be of reinforced concrete. Partitions, except where special conditions exist, will be of hollow terra-cotta block. The window-frames and sash in first-story street fronts will be of cast bronze, of special design, frames and sash in the upper stories will be copper kalameined. Roof will be covered with flat tile roofing. Main entrance will have bronze-covered revolving doors. Vestibules and corridors in first story will have marble floors and wainscot; corridors in upper stories will have mosaic floors and marble wainscot. Staircases will be of ornamental cast iron, with marble treads. Elevator enclosures will be of ornamental iron glazed with wired polished plate-glass, doors to be hung on ball-bearing hangers and provided with improved type of operating devices. All doors and trim throughout the offices will be of hollow metal, enamelled.

The office floors will be of cement, hardened and colored. Toilet-rooms will have tile floors and structural glass wainscot and stalls. The banking-rooms will be wain-

scotted with marble, counters and screens will be of marble and bronze of an ornate character. Ceiling of the main banking-room will have ornamental beams and coffers of plaster. The bank vault and safe-deposit vault will be of the most modern and improved type of fire and burglar proof construction. Directors' room and president's room will be elaborately panelled and wainscotted in hardwood, and will have marble mantels, oak floors, and ornamental plaster ceilings.

The Turkish bath in the basement will be fitted up with structural glass wainscot and rubbing slabs. The swimming-tank will be lined with enamelled brick, and be equipped with formed gutters, life-rail, etc. The plumbing throughout the building will be of the best type, hot-water supply and filtered ice-water supply to all offices. Heating will be done by a vacuum system. The building will be equipped with a complete vacuum cleaning system. The passenger-elevators will be of the gearless traction type; freight-elevator and sidewalk

elevator to sub-basement will also be provided.

A more complete and detailed description of the materials and construction of the building will be given as the work progresses. The lot is practically level, and the old buildings which formerly occupied the site have been removed. Borings have been taken, and the quality of the soil and sub-soil have been pretty well determined. It has been found by the tests that about three-quarters of the building will set upon good sound soil, having a bearing capacity of from four to six tons per square foot, but it was also found that one corner would set on the bed of an old stream, and that the soil was particularly bad and would necessitate piling.

The lines and levels have been properly established by a surveyor as called for in the specifications, and everything is now ready to commence excavation.

CHAPTER II

EXCAVATION, FOUNDATIONS, CONCRETE

On our arrival at the job to take up our duties as superintendent, we found that the contractor had commenced excavating, and was making good progress with the work. Work was being done with a one-yard steam-shovel, and all excavated material was being carted away and dumped as rapidly as it was excavated. Always be sure and see that a sufficient number of carts are provided to move the material rapidly, but if too many are used they will cause congestion around the job, which is liable to make friction with the authorities. On further examination the soil was found to be as the tests showed, a good compact gravel, with no underlying silt or quicksand, except that part where the bottom was particularly bad and had to be piled.

As the excavation progresses, we should

give orders for the excavation of all trenches for water and sewer pipes, and for all connections to the street service for electric wiring. This work should be done if possible by the contractor for the excavating, which will avoid complications and hold one contractor for all street obstructions, etc. The plumber should be notified and he should make all connections for water and sewer, and bring them into the building for connecting to later.

The material having been delivered at the building, sheet piling was ordered to be done at once to support the sides of all excavations. Planks for sheeting were ordered to be of sound, square-edged spruce. For that part of the basement where excavation was only about sixteen feet deep, and for all shallow trenches, two-inch plank were thick enough, but where the sub-basement occurred, and the excavation was about twenty-four feet deep, three-inch plank were required, and in one or two places where deeper excavation was called for, four-inch plank were ordered to

be used. Sheeting was cut to an angle on the bottom edge, and the upper corners of each plank were cut off to decrease the liability of splitting in driving. The driving of the sheeting was done by means of a compressed-air power hammer, a portable air-compressor having been installed to supply air for hammers, drills, riveters, etc.

Sheeting was provided with breast pieces of 6 by 6 timber. In the open excavation the sheeting was held in place by means of inclined shores running from the breast pieces to a heavy plank platform or foot piece on the ground; foot piece should always be of sufficient area to distribute the load over the ground, and should be well wedged up. Wedges were ordered to be of oak, as it is less liable to split and splinter in driving than the softer woods. The sheeting in the trenches was held in place by means of short lengths of plank run from side to side of trench and wedged tight. The sheeting being complete and the excavation well under way, the perma-

nent work for the protection of the public was started. Up to this time we had depended upon plank railings around the excavation, now we must build sidewalk bridges, with plank steps at each end, with plank railings, and a plank roof heavy enough to protect the passers from any injury caused by any falling building material.

The bridges are to be wired for electric light, and have an inner waterproof ceiling. Bridges were built with heavy 10 by 10 stringers, floor and roof beams 3 by 12, spaced 2 feet on centres, posts 10 by 10, with 2 by 6 diagonal braces. Floors and roof were of 2-inch plank. Inner ceiling was of seven-eighths inch sheathing, covered with roofing felt. The contractor's office, with an office for the superintendent, was built on top of the bridge. Office was made weather-tight, wired for electric lights, and provided with a telephone. During the progress of the excavation and while the preparatory work was going on, building materials were steadily arriving on the

job, and we must carefully inspect the same.

A good quantity of sand had arrived, and was ordered to be piled where it would not get dirt from cart-wheels mixed with it, nor be ground up and pulverized by street traffic. By crunching the sand in the hand near the ear, and noting the sound which was hard and grating, it was found to be good and sharp, and an examination under a magnifying-glass showed that it was well-graded, but rubbing the damp sand on the palm of the hand showed it to be rather dirty and to contain some loam. A sample of the sand was taken and put in a clear glass bottle, and the bottle filled with water nearly to the top and thoroughly shaken together and the mixture allowed to settle; by measuring the column with a rule it was found that the sand measured six and one-half inches and the dirt on top measured one-half inch, showing a little over 7 per cent of dirt and loam. The contractor agreeing to thoroughly wash the sand, and promising that all future ship-

ments of sand should be cleaner, we agreed to accept it.

The broken stone was found to be a very good quality of trap-rock, but showed on examination a considerable quantity of crusher dust, and was in consequence ordered to be screened. The stone was ordered in two sizes, that for reinforced work grading from one-eighth inch to three-quarters of an inch in its greatest dimension; that for mass work such as wall footings, under bed of concrete floor in basement, etc., graded up to two inches in its greatest dimension.

A car-load of cement having arrived, it was brought to the job, and the reports of the mill tests were checked, and the laboratory inspection tags, car initials and numbers were all verified and recorded. The contractor was ordered to put up a weather-proof storage shed, with a good tight floor, raised at least twelve inches above the ground, in which to store the cement. In the total shipment there were found to be a few broken packages; these were put to one

side, for immediate use, more preferably in some of the mass concrete which was not subject to very heavy loading.

A sufficient supply of materials being now on hand, and the excavation practically completed, concreting can be commenced at once. All of the concrete, according to the specifications, is to be machine mixed, using a rotary batch mixer. The mixer should make not more than ten or twelve revolutions a minute, and not less than twenty-five complete revolutions should be made for each batch. A gong was attached to the mixer, fixed so as to ring when the fixed number of revolutions had been made. All materials, including the water, must be measured; not over six gallons of water to a bag of cement should be used.

Particular care was taken to note the color of each batch as it comes from the mixer, as uniformity of color must be insisted upon. The concrete for the beds under the column grillage, for all wall footings, and for the under beds of concrete

floors will all be mass concrete, and it was specified to be mixed one part Portland cement, three parts sand, and five parts broken stone. After the concrete was mixed we were very particular in seeing that it was deposited in place as quickly as possible, and that at all times there were a sufficient number of laborers on the job to take the concrete as fast as it leaves the mixer and wheel it to the points where it is to be placed, and that other laborers are ready to ram it into place, being very careful to see that no concrete is used that has been discharged from the mixer over twenty-five minutes. A careful watch was kept on all barrows and buggies to see that no lumps of concrete were allowed to remain in them, and we made it a rule that all receptacles were thoroughly cleaned at the cessation of work.

All pipe trenches in basement and sub-basement, and all sump pits will be lined with concrete, and all foundations for pumps, filters, and other machinery will be formed of concrete. While the work

of placing the concrete was progressing, the piles are being driven in that portion of the foundations where piling was found to be necessary on account of the poor bearing value of the soil. The system of piling finally selected was one in which the pile is formed by driving a collapsible steel mandrel, incased in a spirally reinforced sheet steel shell, then withdrawing the collapsed mandrel, after sufficient penetration had been secured, and filling the shells with concrete. The piles were driven by means of a steam pile-driver, mounted on a turn-table. The concrete used for filling of the shells was the mixture specified for reinforced work. The space around the heads of piles was filled with concrete to make a bed for the column grillage. As soon as the beds for the grillage had set, the steel erectors commenced to set the grillage, about which more will be said in our next chapter. The grillage was well grouted under with cement grout, composed of one part cement and two parts sand, mixed very wet and poured under the

beams. Dams of damp sand should be laid all around the grillage to hold the grout in place until it has set. Each layer of grillage should be filled with concrete after setting; the concrete should be as called for in reinforced concrete. A close watch was kept to see that the concrete was well spaded and rammed in between the beams of grillage to fill all spaces thoroughly. It had been previously decided that that portion of the basement walls which were located over that portion of the lot where the bearing quality of the soil was affected by the presence of the old stream bed, should rest upon concrete beams running from column footing to column footing, instead of the regular wall footings resting upon the earth. This was done to prevent irregular settlement of the walls, which might cause cracking, bulging, and other defects in the walls. These beams, the bottom and side walls of swimming-tank, the walls and ceiling of bank and safe-deposit vaults, and the sidewalk vault walls will be of reinforced concrete. Con-

crete was specified to be mixed in the proportion of one part cement to six parts aggregate, to be measured separately. Proportions to be measured by volume, taking one bag containing ninety-four pounds of cement to equal one cubic foot. The proportions of sand and stone shall be chosen so as to give a concrete of maximum density, but in no case, however, shall the amount of sand be less than 40 per cent of the stone.

The reinforcement of the beams will be of structural grade steel, the bars will have a positive mechanical bond, and are to be bent as shown on the detail drawings where required. The reinforcement of the swimming-tank bottom and side walls will consist of two layers of expanded metal, placed one inch from the inside and outside surface of the concrete. The reinforcement of bank and safe-deposit vault walls, roof and floors, will be composed of fifty pound steel rails, set alternate flange to outside and head to outside, lapped over the top and bottom, and bolted together with long

steel rods, this reinforcing probably giving the best resistance known to drills and explosives. The reinforcing of sidewalk vault walls will be twelve-inch steel I beams, set six feet on centres, the concrete being filled in between. The lumber for the forms for concrete work having been delivered and inspected, was found to be as specified, a good quality long-leaf yellow pine, free from knot-holes, dressed on one side, with the edges dressed to a light bevel to make tight joints. This is better than tongueing and grooving. The bottoms of all beam forms should be of two-inch plank and the sides of beam forms should be of one-and-a-half-inch plank; for all other form work seven-eighths-inch lumber will be sufficient. Care must be taken to see that all forms are properly braced, and that they are tightened up with wire ties. Joist for forms should be 2 by 6, spaced from twelve to twenty-four inches apart, depending upon the height of form work, and thoroughly braced.

We were very careful to see that beam

forms were properly supported by posts, and that the posts were set on bearing platforms on the earth to prevent settlement, and were double-wedged at their feet, so that the work could be set up tight. When the form work was complete the placing of the reinforcing steel should be commenced. We kept a very close watch on this part of the work, checking it very carefully to see that it was done exactly according to the details, and that no deviation was made from the engineers' drawings under any circumstance, as even a slight displacement of the rods materially affects the strength of the concrete. All rods must be properly held in place by means of spacers, and securely wired where necessary; all stirrups must be accurately spaced, as shown on the drawings. Before the pouring of the concrete is started we will look over the forms carefully and see that no shavings, sawdust, or other rubbish are left in them, and have them thoroughly cleaned. More than likely it will be found that the workmen have made them a reposi-

tory for waste paper, old socks, and the refuse from their dinner-pails. All this must be removed. The forms were ordered to be thoroughly wet down and the pouring of the concrete was commenced. In pouring concrete always start at a time so that beams, slabs, or walls will be completed monolithically, if possible, and if work has to be stopped, always stop in the centre of a beam or panel, as at that point the minimum shearing stresses occur. When pouring concrete spade back the stones so as to give a mortar finish to the face, also puddle concrete to work out the air bubbles. If work has to be stopped for any cause, on resuming work the concrete which has been previously placed shall be roughened and thoroughly cleaned of all foreign matter, drenched and slushed with cement mortar composed of one part Portland cement and two parts sand. If the weather is warm we must see that the exposed surfaces of the concrete are kept damp for three or four days to prevent checking by too rapid setting of the cement.

The walls of swimming-tank and the walls of bank and safe-deposit vaults shall have at least two expansion joints in their length. Expansion joints should have a key, and be filled in with asphalt. As soon as the under bed of basement and sub-basement floors and the wall footings were in place and set hard, the waterproofing contractor started in on his work, waterproofing the basement and sub-basement floors, pipe trenches, basement walls, area walls, and swimming-tank. The waterproofing as called for in the specifications was to be done by the membrane method, using a heavy saturated roofing felt, weighing not less than 15 pounds to 100 square feet of single ply, and the best quality of coal-tar pitch. The under bed of all concrete floors, all pits and trenches, and the tops of all wall footings will be thoroughly coated with pot pitch, well mopped on; over this pitch will be laid five layers of felt, each layer being put down separately and well mopped with pitch. The joints in the felt must be made to lap one-fifth the width

of the sheets, and be thoroughly cemented with the pitch. The waterproofing of the floors and the trenches will be continuous, and the waterproofing under the walls will be provided with laps for connecting it to the waterproofing of the floors and the walls. Before the waterproofing under the walls, we must see that the bricklayer has laid a stretcher course of brick along the centre line of the walls to form a key, over which the waterproofing must be laid, otherwise the walls may slip on the smooth surface of the waterproofing. Just as soon as the basement and sub-basement floors are waterproofed we must notify the contractor that he must lay the top portion of concrete floors at once, so that the waterproofing will not be damaged. The swimming-tank will have five-ply waterproofing on the inside of bottom and walls.

The waterproofing of the basement walls will be done by laying up a four-inch brick wall immediately outside the line of walls and covering this wall with five-ply waterproofing, against which the walls will be

built, and the waterproofing will be turned up over the walls at the grade level. While the above work was progressing a quantity of structural steel was being delivered at the job. A sufficient amount being on hand the work of erection will be commenced, about which we will tell in the next chapter.

CHAPTER III

STRUCTURAL STEEL AND FLOOR ARCHES

As the structural steel works were located only a few miles from the building we were able to make occasional visits there for the purpose of inspecting the material while it was being fabricated. All beams and plates were inspected to see that the punching was done according to the drawings, and that all holes were clean-cut and without torn or ragged edges. All shop rivets were inspected. Before going to the shop a one-pound machinist's hammer was purchased at a near-by hardware shop. Tapping the rivet heads with this hammer told whether they were tight or not, and whether they completely filled the holes. A few loose rivets were found and ordered to be cut out and new rivets put in their places. All built-up members were inspected to see that the abutting parts were painted before assembling.

Strict orders were given that all steel should be thoroughly cleaned before painting, all rust and mill scale was ordered removed before applying the paint, where the rust had eaten into the surface of the steel it was ordered to be cleaned with wire brushes. The shop coat of paint was specified to be put on with hand brushes, and well brushed in. No long-handled brushes were to be used. The shop coat was called for in the specifications to be of red-lead and linseed-oil. Paint to be made up by mixing the pure red-lead in a dry state, and the pure linseed-oil in a revolving churn, using 22 pounds of lead to 1 gallon of oil, and mixing immediately before using. Not over 110 pounds of lead was allowed to be mixed at one time, and that had to be entirely used before another batch was allowed to be mixed.

The first of the steel to arrive on the job was the beams for the grillage under the columns. The grillage beams were carefully spaced according to the details, and they were held together by means of

long rods and gas-pipe separators; the grouting and filling with concrete was done as described in the previous chapter; the second tier of beams in the grillage was then set.

Particular care had to be taken to see that the position of the beams was exactly as they were figured on the plans, as the columns should set exactly in the centre of the grillage. The upper tier of beams was bolted together with rods and separators and filled between with concrete, as was the lower tier. Before setting, the shop coat of paint on the beams was touched up in all places where it had been marred in handling, and then the beams were given one coat of paint which had a bituminous base to resist the action of the alkalis in the cement, and also as a proof against any dampness which might come through the concrete. All bolts and separators were painted one coat.

The columns were to set on solid slabs of rolled steel, which were to distribute the loads over the grillage; in this case they were

thirty-two inches square and five inches thick, with both faces planed. The column bases sat upon these slabs and were bolted to them. We were very careful to see that every slab was well painted before setting. After the grillage had been set, the engineer was called to take the levels, and test all measurements to see that all was correct before starting the actual work of erection, for at this time errors can easily be corrected, which will entail great expense if not detected until after part of the steel has been erected. All being found to be correct, the erection of the steel was commenced, columns were set, and girders were put in place ready for rivetting. All work was drawn up close by means of erection bolts, so that the metal from the rivets would not flow between the plates.

Holes were brought in line and matched by the use of drift pins, but particular care was taken to see that the metal was not injured in the driving of the pins. All field rivetting was done by means of a pneumatic riveter. Rivets were inspected to see that

they were long enough to fill the holes and to form a perfect head. All column splice plates were rivetted, and all girders were connected to columns by means of rivets. Connections of floor beams to girders were made by bolting. Columns were plumbed as each section was set. When the third tier of beams had been set the contractor was ordered to plank over the entire first tier of beams, and each alternate tier was planked over as the work progressed. This was done as a protection to the workmen who were working underneath, as a hot rivet or a bolt falling any distance from above is liable to cause serious and possibly fatal injuries to the men below. As the steel was set the shop coat of paint was touched up where it had been marred in handling, and all rivet heads were painted one coat to match the shop coat of the steel. All bolts were dipped in paint before putting them in place. The steel was given a field coat of genuine graphite paint.

All painting was specified to be done with hand brushes and carefully brushed

in. As erectors generally try to slight this part of the work, we were obliged to follow them up pretty closely and insist that the work be done according to specifications, and when they learned that we really meant what we said, the work went along smoothly and well. The bottom flanges of all beams and girders, and the flanges of all free-standing columns, were fitted with metal caging to hold the haunching and the column casing. The caging was made of galvanized steel wire, and came to the job collapsed, and was opened out accordion-wise and adjusted to the flanges of beams and columns. The columns were provided with special web stiffeners to go over the web openings, making a complete cage around the column. As the erection of the steel progressed the ornamental iron contractor commenced setting the strings and risers for the staircase, and ironwork for the elevator enclosures, and the plumber followed close on the heels of the erectors, installing the soil and waste lines and the leaders, so

that there would be no delays in the work.

The strings and risers of the main stairs were of cast iron, moulded and ornamented. As the castings arrived at the building they were looked over to see that they were true to line, with no breaks nor shoulders, that they had no blow-holes, nor sand-holes, and that all gates and fins had been thoroughly ground off. All castings were wire-brushed to remove all sand. All stair work was specified to be put together with countersunk screws, concealed wherever possible. The stair strings were securely bolted to the steel frame, and the risers were bolted to the strings. The stairs were provided with under treads of No. 10-gauge sheet iron, screwed to the risers; this was done in case of fire calcining the marble treads, there would be no danger of a person who stepped on the tread breaking through and being injured. When a few tiers of steel had been set, the forms were put in place, and the reinforcing for the floor-slabs was installed. The forms were constructed as described in the preceding chapter, and hung

from the floor beams and girders. The slab reinforcing was in the form of a continuous steel wire mesh, which was laid the full length of the building and securely fastened to the beams at the walls, and run over the upper flanges of the floor beams.

The edges of the fabric were ordered to be lapped and well wired together, which made a complete sheet of reinforcing over the entire floor. As soon as reinforcing was in place the pouring of the floor-slabs was commenced. Concrete was as described in the previous chapter. It was sent up to each floor by means of a specially constructed hoist, equipped with a dumping bucket, and spread on the forms. All concrete was placed the full depth at one operation. It was found necessary in some cases to stop placing concrete before the entire slab was completed, in which case we instructed the foreman to make the joints in the centre of the panels by means of vertical bulkheads. These bulkheads were provided with triangular strips which formed a 2-inch by 2-inch key in the centre

of the slab. The strip set on top of the steel, and the space between was caulked with a one to two cement mortar. Bulkheads were not allowed to be removed until the concrete had set hard.

The offices throughout the building were to have cement-finished floors. These were to be laid as an integral part of the floor-slab. The contractor was instructed to screed the wet concrete up with a straight edge, bringing it level with the grade of the finished floor. While the concrete was still in a liquid state, the cement finishers started floating this down with a one to one and a half mixture of Portland cement and sand, applied dry and worked into the top of the slab. The finishers then hand floated into this top a one to one mixture of Portland cement, and a metallic hardener, working out all the air bubbles and bringing the water up to the surface. The surface was finished by giving it a hard fanning or burnishing, polishing it thoroughly and completely eliminating all trowel marks. Strict orders were given

that laborers or mechanics should not walk over the fresh concrete, and any who persisted in doing it were ordered to be discharged. The finished floors were covered with one inch of sawdust within twenty-four hours after their completion, and this sawdust was wet down twenty-four hours afterward, and the floors were kept covered, until the completion of the building.

On returning to the building after an absence of a day at some of the shops inspecting material, we found that the foreman was piling quantities of building material on the floor-slabs, which had just about set and that were still quite fresh. This was ordered stopped and the materials removed as rapidly as possible. This practice cannot be too heartily condemned, as the wet concrete is always considerably heavier than when dried out, and the adding of a superimposed load considerably greater than the assumed live load, and very often concentrated on one or two panels, has in some cases caused a collapse of the entire structure.

Before the floor-slabs were poured and after the reinforcing had been placed, the electrician was notified to install all conduit and outlet boxes which were to be buried in the concrete. The installation of conduit, etc., will be treated fully in a later chapter. The steel frame being erected and the pouring of the floor-slabs well advanced, the laying up of the brick-work and the setting of the cut stone and the terra-cotta was now started, and will be the subject of the coming chapter.

CHAPTER IV

CUT STONE, ORNAMENTAL TERRA-COTTA, AND BRICKWORK

THE base course around the building on all of the street fronts was specified to be granite from the quarries at Concord, N. H., to be dressed six cuts to the inch on all exposed surfaces, except the steps at the entrances, which will be eight cuts to the inch. On delivery at the building the granite was inspected to see if it was cut according to the dimensions on the drawings and if the face cutting was as fine as called for in the specifications. Also it was examined to find if there were any seams, any black or white lumps called knots, seams with discolored edges called shakes, or brown stains called sap, any of which would be cause for the rejection of the stone. Bed joints were tested to see if they were worked hollow or slack on the

back of bed, and if in all cases they were at least three inches wide. Seams were easily detected by tapping the stone with a hammer. One suspicious-looking piece was found to have been fractured and patched.

Patching was done by sticking a piece of stone on the fractured piece by means of shellac, and then rubbing stone dust into the joints to make a smooth, even surface. This patched piece was condemned and ordered to be replaced with a sound stone, as in time the weather would destroy the shellac and cause the patch to eventually drop out, leaving the broken stone. All cut stone was specified to be set in non-staining mortar, plastered on the back with the same mortar, and the first course in the backing up brick next to the facing stone should also be laid up by the bricklayers in the same mortar as is used by the stone setters.

The cement selected was Atlas white cement, to be mixed in the proportion of one part cement, one-half part lime paste, and two parts clean sharp sand. The lime

was first slaked with cold water and screened through a three-sixteenths-inch mesh screen into a settling-box. The lime putty was allowed to stand for at least one week, and then mixed with the sand and cement, and used for setting the stone. All sand was screened and washed before using. Care was taken to see that all stone was set in a full bed of mortar and that the mortar was kept back three-quarters of an inch from the face of the stone to allow for pointing. Joints were called for to be one-quarter of an inch thick. Wooden wedges were set in joints at the face of all stones to insure uniform joints; these wedges were not to be removed until the stonework was cleaned and pointed. All stone not easily lifted were ordered to be derrick set, and no Lewis holes were allowed to be made less than two and a half inches from the face of the stone, and where they would be entirely covered by the stone above.

The limestone was delivered at the building properly boxed and numbered accord-

ing to the contractor's setting plans; stone was ordered to be set upon planks to keep it entirely clear of the ground until it was set. Before setting, all stone was inspected for evenness of color and for seams, holes, or cavities filled with sand, clay, or uncemented material. The exposed faces of all stones should be cut true, and all arrises should be full and true, and the front edges of all joints should be cut back one and one-half inches on all beds and joints; no false joints nor mitre joints were to be allowed. Every alternate course in the ashlar was bonded into the walls twelve inches, and every intermediate course was bonded eight inches into the walls. All stones in projecting courses were examined to see that in all cases the beds exceeded the projection of the stones beyond the face of the wall.

Each stone was secured in place by means of two galvanized-iron anchors three-sixteenths of an inch by 1 inch, turned up 2 inches in the brickwork and 1 inch down into the stone, and we insisted upon proper

care being taken in the cutting of all anchor-holes, so that a good grip in the stone was given for all anchors. As the stone setters never like to do this part of their work carefully, seeming to think anything will do so long as the anchor is there, a little insistence on the part of the superintendent is generally necessary to get proper results. Wherever it was deemed necessary, more than two anchors to a stone were called for, and in some cases the stones were ordered bolted down with galvanized-iron rods with square washers at the top and bottom.

All window-sills were set with open under joints, to be pointed up at the completion of the building, so as to prevent cracking from settlement. All of the top joints in projecting courses and balconies were specified to be caulked with oakum and pointed up with an approved plastic cement. As soon as the stone was set the foreman was ordered to protect all projections, top surfaces, and angles with proper boarding, thoroughly secured to the work, and to

keep it protected until the completion of the building.

All carved stone was to be boasted out ready for carving. This we inspected very carefully to see that in all cases sufficient material was provided to give the required relief to the carving. Great care was exercised to prevent splashing of the stone with mortar when setting it, and any mortar which may have been splashed on the stone was cleaned off before it had set. While the stone was arriving and being made ready for setting, the brickwork was started and carried up ready to receive the stone, and the stone was backed as rapidly as it was set.

All walls and piers in the basement, the backing up of all front walls, and the rear wall in the first story were of brick.

A number of loads of brick were delivered at the building. We looked them over as they arrived, and found them to be of good, even color and well shaped. By striking two together and finding that they gave a sharp, ringing sound, and repeating

the process with a number of the bricks, they were found to be hard-burned.

The mortar for use in laying up the brick was specified to be composed of one part Portland cement and three parts good, clean, sharp sand, with the addition of ten pounds of hydrated lime to each bag of cement. The addition of hydrated lime, or lime putty, is a very good practice, as it renders the mortar more plastic, causing it to spread better, and also decreases its permeability to moisture. On large work in the city hydrated lime is more convenient than lime putty, as it does not have to be slaked ahead, and a large amount of space does not have to be given up to storing the lime paste while it is seasoning. Before laying, all brick should be thoroughly wet. There are four good reasons for the wetting of brick before laying: first, the bricks will be better bedded on the mortar under them; second, they will adhere to the mortar better; third, a dry brick soaks water out of mortar very quickly, and mortar will not set properly unless it dries

slowly; fourth, wetting the brick washes the dust from them, and clean brick offer the best surface for mortar to adhere to. In wetting brick be careful not to wet them to a point where they will run out of place when laid in the mortar. Particular attention was paid while the brick were being laid that they were laid to the line, that the walls were plumb and true, and that all brick were well bedded and slushed up with mortar.

We were just in time to catch one of the bricklayers doing what is a common and a very bad practice on steel-framed buildings, that is, in bricking up around the wall columns, to lay up the outside brick several courses high, one course thick, bonding into the wall, and then filling the interior space around the columns with brickbats and mortar thrown in at random. This work was ordered torn down and rebuilt in a proper manner, all brick being properly bonded and built in around the columns.

The walls above the second story were

to be of hollow tile 8 inches thick, faced with four inches of brick, and bonded together with special header backer tiles, bonding every sixth course of brick. This type of wall has several advantages over the solid-brick wall: first, the decreased weight, a square foot of solid-brick wall 12 inches thick weighing about 120 pounds, whereas, a brick-and-tile wall 12 inches thick only weighs about 87 pounds per square foot, which makes quite a reduction in dead load, thereby making it possible to use smaller wall girders, smaller column sections, and smaller grillage, materially reducing the steel tonnage; second, the hollow-tile wall makes furring unnecessary, as the plaster can be applied directly to the scored surface of the tile, and the hollow tile makes an insulated wall which renders the building warmer in winter and cooler in summer. The walls on the three street fronts above the third story will be faced with a selected front brick laid with a wide-cut joint. Window-sills, lintels, belt courses, and main cornice will

be of matt-glazed terra-cotta. Before commencing to lay up face brickwork, the contractor should lay up a sample panel at least four feet square to determine the width of joints, etc. After this has been approved the work can commence.

We were very careful to see that the mortar for laying up of the front brick was mixed very stiff and with coarse sand to obtain joints of the required thickness; also care was taken that the ingredients in each batch were measured to obtain an even color in the mortar. The foreman was instructed to back up all face brick before quitting work, so that the mortar would not dry out a lighter color, nor its strength be decreased.

All terra-cotta was examined on its arrival for warped, kiln-cracked, crazed, surface-checked, chipped, or painted pieces. A few were found which were checked and cracked, they were condemned, and the contractor was ordered to replace them with perfect material without delay. The top joints on all sills, belt courses, and the

main cornice were raised. All terra-cotta was anchored back into masonry with galvanized wrought-iron anchors, ties, and bolts. All portions of the terra-cotta inside the face of the walls were filled solid with bricks and mortar, but care was taken that no part of the terra-cotta which projected beyond the face of the walls should be filled.

The window-frames were set as the walls were laid up, care being taken to see that they were plumb and in line and that they were properly stayed. In the case of tall frames we ordered spreaders put in between the sides of frames to keep the brickwork from bowing them in.

Brick and terra-cotta were pointed up, as the work was laid, and left ready for cleaning down at completion. When the walls were up a few stories and the floor-slabs had set and the forms had been removed, the work of setting the terra-cotta partitions and wall furring was commenced so that there would be no delay in the work, and that as soon as the building was enclosed

and the roof covered, the plastering could be commenced.

To give architectural effect, and also to keep out the dampness, the walls in the first story were to be furred with hollow-tile furring blocks. The blocks should be anchored to the walls with galvanized-iron anchors. All pipe and conduit will be furred around, and the furring which runs around pipe will be tied back to the wall with galvanized-iron ties. Wherever the furring is run over window-heads, the contractor must set angle-iron lintels to carry the furring; lintels must be painted to prevent rust from staining the plaster. All partitions, except some special partitions in the basement and in the banking-rooms, will be of hollow, porous terra-cotta blocks laid in cement mortar, and anchored together with galvanized-iron ties. All blocks should be examined to see if there are any cracked, warped, or soft blocks among them, which must be condemned. See that the blocks are thoroughly wet before laying. All openings for doors and

windows will have steel channel bucks, as wide as the thickness of the partitions; the sides of the bucks must butt against the head-pieces, which will build into the partitions one foot on either side of the opening. The bucks must be tapped to fasten the frames and trim to them. Where the bucks are not covered by the trim they must be lathed over with metal lath to prevent the plaster from cracking.

The walls having been topped out, the parapet walls built and coped, the next important step in the construction of the building is the laying of the roof, which in this particular case will be of flat promenade tile. Before laying the roofing, the roof-slab should be thoroughly cleaned off, and all slopes and crickets formed with cinder fill, composed of one part Portland cement, two parts sand, and ten parts clean, steam cinders. We inspected the cinders carefully to see that they contained no ashes, and ordered them thoroughly washed to remove all sulphur and dirt. The cinder fill was given a screed coat of

cement mortar one inch thick to level it off, and all rough places in the roof-slab were levelled off with cement mortar, so as to make a good, smooth surface for laying the roofing felt.

The entire roof surface was given one good coat of hot coal-tar pitch well mopped on. On this coat of tar was laid five layers of heavy saturated roofing felt; each layer was coated with hot coal-tar pitch, and each sheet was lapped one-fifth of its width, and the joints cemented one-third of their width with the pitch. The junctions of the roof with all vertical surfaces were flashed with sixteen-ounce soft-rolled copper, the flashing was laid in between the third and fourth layer of felt, and extended out not less than four inches on the roof, and was carried up twelve inches on all vertical surfaces.

The flashings were all cap-flashed. We were careful to watch and see that all cap-flashings were built a full four inches into the walls and turned down not less than three inches over the flashings. The sheets

of copper which formed the flashings were put together with a lock joint and soldered; the edges of all sheets were tinned before soldering, so that the solder holds better. The tile was laid on top of the felt, and was well bedded in cement mortar. They were butted up close against all flashings. The connections to rain-water leaders were made by means of patent roof connections with cast-brass strainers and expansion joints, which are far superior to the old-time copper scuppers and spouts.

All of the penthouses around stairways, elevators, and tanks were built up of hollow terra-cotta blocks in angle-iron framing. The outside walls were plastered three coats of waterproofed cement stucco. The mortar for plastering was composed of one part Portland cement, three parts sand, with the addition of ten pounds of hydrated lime to each bag of cement. We were obliged to watch this part of the work very closely to see that the mortar was properly mixed and that only a small quantity was mixed at a time, the cement, sand, and

lime being mixed together dry and then wet, and the whole turned over until it reached a uniform color and consistency. No mortar which had been mixed over thirty minutes was allowed to be used, and no mortar was allowed to be retempered under any circumstances. The building was now ready for plastering and the laying of the tile and mosaic floors.

CHAPTER V

PLASTERING, MARBLE AND TILE WORK

THE ceilings in the first story were to be furred and lathed with metal lath, and the top story had a hung ceiling two feet below the bottom of the lowest roof beams to give an insulating space under the roof. To carry the furring, steel hangers were clamped to the flanges of the beams; to these hangers were bolted one and one-half-inch by one-quarter-inch running bars spaced five feet apart. To these running bars were clipped by means of No. 9 gauge galvanized-wire clips three-quarter-inch steel channels, spaced twelve inches on centres; this formed the furring to which the lath was to be fastened.

Where the beams in the coffered ceiling of the bank occurred, longitudinal rails of one inch by three-sixteenth-inch flat steel, fastened to the floor beams, were run, and

to these rails were fastened brackets of flat steel bars, which were bent to conform with the shape of the beams, and were spaced twelve inches on centres. To hold the whole frame in place stiffening rods of three-eighths-inch round steel were run at right angles to the brackets and securely wired to them.

The lath which was used was a galvanized No. 18-gauge wire lath. It was tied in place and drawn tight to the furring with No. 18-gauge galvanized annealed wire; ties were spaced every six inches, given a double turn, and the raw ends bent back flush with the face of the lath. All end joints were lapped two inches, and care was taken to make all side joints along a furring bar, and they were lapped one inch and securely laced together. The ceilings were all carefully tested to see if they were perfectly level and true before starting the plastering. All of the external angles throughout the building were protected with galvanized-iron corner beads, which were secured to the terra-cotta block

partitions by means of iron clips three inches long, which held them firmly in place.

In some of the rooms in the bank, and in the tiled rooms in the Turkish bath in the basement, two-inch solid plaster partitions were called for. These partitions were constructed of galvanized corrugated expanded sheet-metal, secured at floor and ceiling with special expanded metal angles. After setting the lath, the partitions were ordered to be braced with temporary bracing, until the plaster was on and set, for although these partitions are very firm after the plaster has set, the lath is very shaky until the plaster has been put on. Before the plastering was commenced the carpenter closed all exterior openings with well-braced wood frames, and covered them with heavy muslin to keep out the weather.

The plastering was done with patent plaster, which is by far the most efficient method of plastering a large building in a city, as it is practically impossible to slake enough lime and keep it on hand for

any large operation, whereas patent plaster can be mixed and used at once; in fact has to be done that way on account of the nature of the material. All plastering which was done on lath was three-coat work, and that which was done on terra-cotta walls and partitions and on the concrete floor-slabs was two-coat work. Bevelled grounds thirteen-sixteenths of an inch thick of dressed white pine were set at all openings, and wherever required, and plastering was ordered to be worked up full to the grounds.

It is a great mistake to put patent plaster on too thin, and a great many unsuccessful jobs of plastering can be traced back to this error. The plaster for the scratch-coat was fibred, but that for the brown coat was unfibred. When the plaster was mixed particular attention was given to seeing that all mortar boxes were clean before starting to mix the plaster in them, and that they were thoroughly cleaned out after each gauging. The mortar mixers were warned not to wash hoes and shovels

in the gauging water. Not more than enough plaster to last one hour was allowed to be mixed at a time on account of the quickness with which it sets, as patent plaster, unlike lime plaster, sets instead of drying. No plaster which had commenced to set was allowed to be used. We were very careful when the scratch-coat was put on to see that the plasterers applied enough pressure to push it through the mesh of the lath and give it a good key. Plaster was filled in between window-frames and walls in all cases to make a wind-stop.

All terra-cotta partition tile and furring were ordered to be well wet down before commencing any plastering on them. The brown coat was properly screeded up and finished with straight edge and darby, using a float to knock off all lumps and fill cat faces. Once or twice during the progress of the work we noticed some of the plasterers picking up some of the droppings on the staging and using them on the ceiling; this we ordered stopped at

once, as the droppings have frequently commenced to set, and do not as a result have a good adhesion, so that any jar on the floor above will cause a fall of a portion of the ceiling, with the accompanying discomfort to the occupants of the room. The finish coat of plaster on all walls and ceilings was composed of hydrated finishing lime, gauged with twenty-five pounds of calcined plaster to each one hundred pounds of lime. The finish was trowelled smooth, and all brush marks worked out.

The ornamental plaster-work in the banking-rooms was done before the finish coat was put on the walls. The beams and cornices were given a scratch and brown coat of plaster, roughly following the profiles over which the gauged plaster was to be run. The plaster for all run mouldings was mixed in the proportion of two parts plaster of Paris and one part of well-seasoned lime paste, so that it would not set too rapidly as it was being run. All ornamental mouldings and applied ornaments on the surface of the ceilings were

cast from pure plaster of Paris and set in freshly mixed plaster. We were careful to see that all of the work was well mitred and joined, and that all ornaments were centred in the panels, all of which contributes to the mechanical accuracy of the work. When the plastering was completed the installing of the interior marble and tile work was commenced.

All of the vertical surfaces of the marble which were not carved were highly polished; the floors and stair-treads were hone finished. In all cases the base course was ordered to be set before laying the finished floors. All of the marble work was set in plaster of Paris, and the plaster was called for to be the best casting plaster. Where the marble bases had to set out any distance from the wall we instructed the contractor to build brick backing for marble; brick was laid up in lime mortar, so as not to stain the marble.

Before laying the floors we had the concrete slabs thoroughly swept broom-clean, and then thoroughly saturated with clean

water and sprinkled with dry cement to the thickness of about a sixteenth of an inch. A levelling coat of cement mortar composed of one part Portland cement and three parts clean-washed sand was put down, and the floors were laid on this bed. The floor of the first-story vestibule and halls was of marble tile, 8 inches by 12 inches, with border strips. The marble used was pink-and-gray Tennessee marble, which on account of its hardness gives an excellent wearing floor. In laying marble floors, where two or three kinds of marble are used to get color effects, care should always be exercised to select marbles of very nearly the same degree of hardness, otherwise walking over them will wear down the soft marble faster than the harder ones, giving an uneven surface which is very disagreeable to walk upon. The marble tiles which composed the floor were bedded in the cement mortar and well grouted with cement.

The floors in the corridors in the upper stories were of marble mosaic. Before

commencing to lay the mosaic an open-mesh galvanized-wire netting was placed on top of the cement levelling coat; to prevent cracking of the flooring, the netting was stretched tight and fastened at the ends to hold it firmly in place. The mosaic was composed of a field of Carrara chips and a fret border composed of colored marbles. Borders were set upon heavy paper, face down, and laid in strips on the levelling coat; fields were set by hand in the cement. Care was taken to see that the mosaic was kept to a line. After the mosaic was laid it was well grouted with cement, and when the cement had set the entire floor was ground down to an even level surface by means of electrically driven carborundum wheels.

The walls of the first-story corridor and the banking-room were wainscotted with marble up to the cornice, with pilasters, panelling, etc. All of the corridors throughout the building had a plain marble wainscot seven-eighths inch thick and five feet high, with base one and one-eighth inches

thick by eight inches wide, and a plain cap one and one-eighth inches thick by four inches wide. All offices had seven-eighths-inch marble base six inches high. All marble was well anchored as it was set with No. 6-gauge copper-wire anchors; all slabs were anchored by the edge, and all corners of the pilasters and wainscoting were cross-anchored. The anchors were well wedged in and covered with plaster of Paris. The marble was backed up with plaster of Paris as it was set. All joints in the marble should be as neat and close as possible, and none of the slabs should have the edges chipped or spawled in the setting. No screws were allowed to be used in the face of the marble work.

The treads and platforms of the stairs were of gray Tennessee marble one and one-half inches thick, with rounded nosings. The treads were secured to the iron risers and strings by means of brass screws, the marble being drilled, and the holes filled with lead to give a grip to the threads of the screws.

All of the toilet-room floors were of three-inch hexagonal vitreous tile, and the walls of toilet-rooms were wainscotted to the height of seven feet with 3-inch by 6-inch enamelled white tile, with a sanitary base and moulded cap. Tile by reason of its being absolutely impervious, makes the most sanitary material known. The bed for the floor tile was prepared the same as that for the mosaic flooring. Tile were placed upon the mortar and firmly pressed into place, and tamped down with block and hammer until exactly true and even with the finished floor. All tile were grouted with cement mortar, the grouting was ordered done the morning after laying, to insure a proper bond between the grout and the cement mortar. All surplus grout was removed before it had commenced to set.

The walls of the toilet-rooms were prepared for tiling by giving them a scratch-coat of cement mortar, mixed one part Portland cement to two parts sand, and well scratched horizontally. The cove base was set before setting the wall tile to give

a good start for the tiling. Wall tile were set by buttering; this was done by spotting tile on the walls about thirty inches apart, and plumbing them accurately with the finished face of the wall. The scratch-coat on the walls was thoroughly saturated with water. Neat cement mortar was spread on the back of each tile, and they were gently tamped into place and plumbed with the spot tile by means of a straight edge. After the tile had set, the joints were washed out and filled with a thinly mixed white Portland cement. Care was taken to see that all cement was cleaned off before it hardened.

The only defect to watch for in wall tiling is crazing. All of the enclosures around the water-closets in the toilet-rooms and the back linings of the compartments were of structural glass, with white enamelled iron door-stiles. This material, on account of its being absolutely impervious and practically non-staining, and offering a great resistance to abrasion, makes a most ideal partition for use in

public toilet-rooms. The partitions were erected according to standard details and specifications, issued by the manufacturers.

When the work just described was completed, the building was ready for the metal and wood trim, much of which had arrived at the building and was ready to be installed.

CHAPTER VI

SHEET-METAL WORK, ORNAMENTAL IRON AND CARPENTER WORK

BEFORE the plastering was commenced the skylights on the roof were set and glazed. They were constructed of galvanized rust and corrosion-resisting sheet iron, which is made up from a pure iron-ore base. The bars in skylights were made up of No. 24-gauge metal, with condensation gutters formed on the bars; they had wrought-iron stiffening bars incased in the sheet metal. These bars were well painted with red-lead before the skylights were assembled. The skylights had gutters around the eaves, into which condensation gutters discharged, and were provided with leaders to discharge all water onto the main roof. Wherever the galvanized iron was brought down onto the skylight curbs, it was kept away from the copper by means of a three-

eighths-inch wooden strip placed between the two metals, to prevent electrolytic action. All skylights except those over the elevators were glazed with wired glass; the skylights over the elevators were glazed with rough plate glass, one-eighth inch thick, and protected with heavy galvanized wire-netting guards, inside and outside, which is one of the requirements of the National Board of Fire Underwriters.

While this work was being done, and the plasterers were still working, the ornamental inironworkers were busy setting their work, the vault-lights in the sidewalk being set as soon as the construction was ready to receive them. The vault-lights were constructed with reinforced concrete frames, set with prismatic glass, and fitted with abrasive metal buttons, to prevent pedestrians from slipping, which is the cause of many serious accidents. The coal-hole covers in sidewalk were placed as near to the curb as practicable, and were of the flush safety-hopper type, of abrasive metal with concealed hinges.

On the interior, work was commenced setting the ornamental railings for the staircase. All castings were inspected as previously described, and a few were found to have sand holes and to be defective, and were rejected. In the setting of this work no exposed screw heads were allowed, all of the work having to be put together by means of concealed screws and rivets, and had to be fitted without breaks or shoulders. The elevator enclosures were made up of cast-iron frames, glazed with polished plate wire glass. The doors to enclosures were hung on ball-bearing, two-speed hangers, made with an enclosed track, hung from an angle iron bolted to the inside of the elevator enclosure; the hangers had adjusting screws so that they might be quickly adjusted at any time, and kept in perfect alignment. Elevator-door saddles were grooved to hold doors in place, and were made with a non-slipping surface, as the usual iron elevator-door saddles become very slippery with use, and are dangerous to passengers.

The elevator doors were equipped with combination liquid and spring checking and closing devices, with positive electric interlocks which made it impossible to open the doors until the car had stopped, or to start the car until the door was closed. The doors were opened by hand and closed by the action of the spring in the closer; the piston descending through the liquid in the cylinder checked the door in the last few inches of its travel, and prevented slamming. The electric interlocks were connected to the arm of the closer and were wired in series with the elevator control circuit, so that when the door was closed the circuit was closed, and when the door was opened the elevator control circuit was opened, thus absolutely preventing any movement of the elevator-car while the door was open.

In each elevator there was installed an emergency release switch, so that in case of fire or other emergency the interlock was made inoperative.

The setting of the window-frames and

sash was progressing during the time that the other work was going on, and they were now all in place. The windows in the first-story on the street fronts were of cast and wrought bronze, of a wind and weather tight construction. The cast and wrought bronze was to be of even color throughout. All of the wrought bronze was worked through steel dies, and had to be carefully examined to see that all mouldings were true and straight, and none was allowed to be less than No. 10 standard American bronze gauge in thickness. All cast bronze had the fireskin removed, and all of the ornament was rechased. Castings were all inspected for sand holes and defects in finish. All joints in frames and sash were brazed, and the work was put together by means of concealed screws and rivets. The glass stops and hardware were held in place by means of screws of the same alloy and color as the rest of the work; brass screws were positively not allowed to be used.

The frames and sash in the upper stories of the building were made up of sound,

thoroughly seasoned white pine, and covered on all exposed surfaces with sixteen-ounce soft rolled copper. The covering was carried into the glass rebates of the sash. The frames and sash were inspected to see that all metal was drawn down smooth over the wood, and that it was free from kinks and buckles, also that it was turned down over the wood at the intersections, and that all joints were well soldered, so that no water could reach the cores and cause decay. All sash were provided with glass stops covered with twelve-ounce copper.

All of the glass in elevator enclosures, metal sash and metal-covered sash was well bedded in self-hardening putty before applying the glass stops. The putty was made up in the proportions of 87 per cent pigment and 13 per cent vehicle; the pigment was composed of 85 per cent whiting, 10 per cent pure white-lead, and 5 per cent litharge or monoxide of lead; the vehicle was pure raw linseed-oil. This putty was used, as the ordinary glazing

putty, composed of whiting, white-lead, and oil will not harden on metal surfaces. The work of glazing the windows being completed, and the plastering having thoroughly dried, the work of setting the steel trim and hanging the doors was commenced. All of this work was made up of furniture stock drawn steel, which was patent levelled and finished in five coats of enamel baked on. All joints in trim were made interlocking and were electrically welded. The angle joints in all mouldings were formed by coping the vertical mouldings over the ends of the horizontal mouldings, which gives the appearance of a perfect mitre, and imparts the greatest strength to the joint. All of the work was erected and fastened by means of concealed fasteners on the back of trim, so that no nails or screws were exposed on the face of work.

The door-jambs were made up of No. 18-gauge metal, formed of one piece, with moulded stops. The jambs were securely fastened to the steel bucks. The doors

were made up of No. 18-gauge steel, with panels of one thickness of No. 12-gauge steel. The stiles and rails were formed from one piece of metal brought together on the inside edge and turned back upon itself, thereby forming a lip to receive the panels, and then rivetted together. The doors had iron reinforcements on the inside to receive the hardware. All of the hardware was of patterns especially designed for hollow-metal construction. The transom lifters and door checks were of the concealed type. Locks were of the unit type, and were master-keyed and grand master-keyed.

The carpenter work on a building of this type is not a very large item, but is nevertheless still a necessary item. The carpenter makes all of the rough centres for the arches and does whatever wood-framing there may be to do throughout the building. After the roof was covered the flagstaff was set in the iron foot block which was provided for it. Although steel flagstaffs are made and are more fire re-

sisting than wood ones, the fire risk is so infinitesimally small that it is better to use a wood staff, which can be made far more graceful than a steel staff. The staff on our building was figured to show forty-five feet above the cornice, and to be nine inches in diameter at the base. It was worked from a selected stick of Oregon fir. As no instructions had been given for tapering the staff, we gave orders that the top diameter should be four and one-half inches, which was one-half the lower diameter. The height of the staff was then divided into four quarters, the diameter of the first quarter above the roof was made fifteen-sixteenths of the lower diameter, the second quarter was seven-eighths of the lower diameter, and the third quarter was three-quarters of the lower diameter. The flagstaff was finished at the top with a lignum vitæ truck with a hollow spun-copper ball, eight inches in diameter, set on a galvanized-iron rod, one-half inch in diameter. The flagstaff was painted two coats of white-lead and

oil before it was erected and one coat after erection. The ball was gilded with leaf-gold.

The carpenters had already commenced work in the banking-rooms while the metal trim was being set in the building. The floor sleepers were laid on the concrete floor-slabs; they set sixteen inches on centres and were nailed to spot grounds set twenty-four inches apart and well bedded in cement mortar, and carefully levelled up to receive the sleepers. The sleepers were 2-inch by 4-inch, short-leaf yellow pine, bevelled on both sides. The first load of sleepers which were delivered at the building were only bevelled on one side, which is quite a saving to the contractor, as a wide stick is run through the saw once and two sleepers are the result, whereas to bevel both sides means running each piece through the saw twice. We ordered these sleepers removed from the building and sleepers bevelled according to the specifications furnished in their place. All sleepers were given a brush

coat of creosote wood preservative before laying. After the sleepers were in place they were filled between with cinder concrete made up of one part Portland cement, two parts clean, sharp sand, and ten parts clean steam cinders. The cinders were well washed to remove all sulphur and other foreign matter.

After the cinder concrete had set, the under flooring was laid. The under floors were of one-and-one-eighth-inch, C-grade, square-edged boards, laid with open joints, not less than one-quarter of an inch wide, and well nailed to every sleeper with two eight-penny nails. By this time the finish for the directors' room and the president's had arrived and was being installed. Care was taken as soon as the finish arrived at the building to stack it so that it would not be damaged, and in a thoroughly dry place, so that it would not absorb moisture, strict orders having been previously given to the cabinetmaker not to deliver any finished material on damp or rainy days, as kiln-dried material absorbs mois-

ture very readily, and the result of the kiln drying is entirely lost if the wood is allowed to become filled with moisture. We made several visits to the cabinet shop to inspect the work while it was being made up.

The finish in the directors' room was specified to be of first quality Honduras mahogany, all of the work to be veneered. The face veneers for panels were cut one-twenty-eighth of an inch thick, the veneers for stiles and cross rails and for doors were cut one-eighth inch thick, and the end veneers of doors were one-half inch thick. All of the large wall panels were veneered in four sections carefully matched, using a crotch mahogany. All of the panels were built up of what is known as five-ply laminated construction. The cores for all of the work were made up of well-seasoned, C-grade white pine, free from loose knots and shakes, care being taken to see that all of the wood was old stock. It was glued together in strips not more than three inches wide. The work was glued

up at least two weeks before any of the cross veneering was done. The cores were all carefully levelled up perfectly true, and brought to an even thickness, and then veneered with a one-eighth-inch white-wood veneer and then cross-veneered with the mahogany veneers. The backs of all panels were veneered with the same stock mahogany as the fronts, to prevent warping and twisting. All doors were veneered on built-up cores and were framed together with mortise and tenon; the tenons were made with three-quarter-inch shoulders, and were securely wedged and glued into the mortises.

The stiles and rails of the doors were grooved on the inner edge and a five-eighths-inch white-pine cleat was glued into the grooves to receive the panel mouldings, so that the panels would be loose. The woodwork was all built up and put together at the factory, and was dowelled and fastened with lag screws at the corners. The finish in the president's room was of unselected birch, to be enamelled. This wood, on

account of its hard surface, density, and texture, takes enamel particularly well. The back of all of the woodwork was given a heavy coat of damp-proof paint before leaving the factory. In erecting the woodwork at the building it was all required to be back-fastened, as no face nailing or screwing was allowed.

Practically all that was now left to be done in this portion of the building was the finishing of the woodwork and the laying of the parquet floors, which was not done until the woodwork was finished. Before applying any finish to the woodwork it was all carefully sandpapered with the grain, and thoroughly dusted off and wiped clean. The mahogany woodwork in the directors' room was washed with a mild potash solution to kill all sap, and to remove any grease in the wood. It was then given a coat of acid stain applied with a sponge, and then rubbed into the wood with a cheese-cloth pad which distributes the stain evenly over the surface of the wood; the work was then sanded

down with 00 sandpaper, and given another coat of stain, diluted with one-half water. It was then filled with a paste wood-filler, which was allowed to set until a flat effect was produced, when it was rubbed briskly across the grain with a piece of burlap, and the surplus filler wiped off with a clean rag. After that it was given three thin coats of pure gum shellac, and sandpapered between each coat with 00 sandpaper, the final coat being rubbed down with pumice-stone and water, and it was finally finished with two coats of prepared beeswax.

The woodwork in the president's room was given a priming coat of pure white-lead reduced with equal parts of linseed-oil and spirits turpentine, then two coats of special enamel undercoating and two coats of an approved enamel were applied, each coat being allowed to harden thoroughly before another coat was applied. Each coat was sanded with 00 sandpaper, and the final coat was rubbed to a dull finish with fine pumice-stone and water. The painter was instructed to shellac and

varnish the bottom and top edges of all doors to prevent moisture from entering the stiles, which is a frequent cause of swelling and twisting of doors, with the consequent annoyance to the occupants of the building.

After the woodwork in the directors' room and president's room had been finished and was thoroughly dry, the finished floors were laid. Before laying the finished parquet flooring a levelling floor five-eighths of an inch thick was laid on top of the under flooring and running in the opposite direction. The parquet flooring in the directors' room and the president's room was of Philippine teak, and that in the working space in the bank was of clear white maple. The flooring was five-eighths of an inch thick, in two-inch by eight-inch strips, tongued and grooved, and laid herringbone pattern, with four-inch wall-line borders. It was blind-nailed, with one-and-one-eighth-inch No. 15 cement-coated parquet-flooring nails, using two nails to each strip.

After the floors were laid, they were

hand scraped, the scraping being done with a shearing cut lengthwise of the grain. They were then gone over thoroughly with No. 1½ sandpaper, swept clean, and wiped with a soft cloth until all of the dust was removed, and were then ready for finishing. They were given a wax finish, after first filling with wood alcohol and light-colored umber, mixed to the consistency of thick cream, which was thoroughly rubbed into wood, followed with two coats of alcohol shellac, each coat being well rubbed when dry, then one coat of linseed-oil and pumice-stone, and one coat of wood alcohol and turpentine in equal parts were applied, and finally three coats of prepared floor wax, rubbed in with hot irons.

The work described in this chapter completed the general construction, and while it was in progress the work of installing the plumbing, heating, electric wiring, elevators, bank fixtures, and vaults was progressing, and was now completed and will be described each in its turn.

CHAPTER VII

PLUMBING AND DRAINAGE

In an earlier chapter, we mentioned that the plumber installed the soil, waste, vent, and leader lines close behind the steel erectors, so that when the frame was up and the floor-slabs set, the lines were all in and most of the roughing for the fixtures was already done. All of the stacks were specified to be of galvanized wrought-iron pipe; this was done after a careful study of conditions. There is no question but that cast-iron pipe is far more corrosion-resisting than wrought iron, in fact it seems to last indefinitely under almost all conditions, but there is one great objection to cast-iron pipe, especially in tall buildings, and that is, the joints. The unequal expansion of lead and iron is something which cannot be overcome, and the joints in tall stacks of cast-iron pipe are always liable to leak,

whereas the screw joints in wrought-iron pipe are steam, gas, and water tight, and under almost all conditions remain so. The only point is to be careful to get a genuine puddled wrought-iron pipe and not a steel pipe.

All of the pipe used throughout the building was standard-weight lap-welded pipe, and the fittings were recessed, screw-jointed, galvanized, cast-iron drainage fittings. The ends of all pipe were reamed out to remove the burr caused in cutting. All pipe and fittings were screwed together, and made perfectly tight without the use of red-lead or pipe cement. The soil stacks were five inches in diameter, which is ample for a building of any height, and with any number of fixtures; the waste stacks for the lavatories in the offices were all three inches in diameter; and the leaders were proportioned so that they had one inch of sectional area of pipe to every 250 square feet of roof area drained. In this instance, the area of the surface drained by each leader was about 7500 square feet, so six-

inch leaders were sufficiently large for the purpose. All of the stacks were supported at their base by means of iron pipe rests placed directly under the stack, and they were supported at each floor by means of iron hangers securely fastened to the floor beams. Venting was done by the circuit system of venting, using the yoke type of vent for all batteries of fixtures in the toilet-rooms on the various floors. The vent stacks were four inches in diameter and were carried up through the roof in all cases.

The house drains and house sewers were laid with a pitch of one-half inch to each foot of horizontal run, and as the total roof area was about 30,000 feet, two lines nine inches in diameter were required. The house drains were hung from the steel floor beams by means of heavy wrought-iron hinged pipe-hangers, and where they ran under the basement floor, they were run in concrete trenches and were set upon brick piers placed every ten feet in the length of the pipes. Brass screw cap clean

outs were placed in the lines at points where they could be easily rodded to remove obstructions. The house sewers were of salt-glazed earthenware pipe, ten inches in diameter, with joints made by means of oakum gaskets, and one to one Portland cement mortar, and connected with the city sewers in the streets.

As the plumbing fixtures in the sub-basement were located below the sewer level, a cast-iron sewage receiver was installed, fitted with a duplex ejector consisting of two centrifugal pumps operating in a dry pit, and driven by vertical electric motors mounted on the extended receiver cover, and equipped with automatic controllers operated by a simple float mechanism, which started one of the motors when the sewage reached a certain level in the receptacle. The adjustment of tappets on the float rod was such that in case of the failure of one pump to start, a further inflow of sewage would cause the other unit to start. The sewage was discharged into the receiver, forced out by the ejector,

and discharged into the sewer. In case the dry pit became flooded from any cause, the ejecting pumps were fitted with auxiliary valves to pump out the pit. For the handling of seepage water, leaks, etc., a sump pit was located in the sub-basement fitted with a grated top. In this pit was installed a water-ejector, fitted with a float which, when it reached a certain point due to the rise of water, automatically opened the valves in the water-supply pipe, which threw a jet of water into the exhaust line, and by creating a partial vacuum sucked out the water.

The ejector, although of small size, having only a one-inch supply, would lift 800 gallons of water an hour on a twelve-foot head. When the lines were all in and ready for the fixtures, the system was thoroughly water tested; the testing being done in sections to avoid excessive pressure, on account of the height of the stacks. The testing was begun at the upper part of the system, and the several sections were tested down to and including the house drain.

The ends of the pipe were closed with testing-stoppers, and the stacks were filled from the bottom, letting the water rise slowly to the top. Any leaky joints that were found were made tight.

The water-supply was taken from the mains in both streets, so that in the event of one main being temporarily out of service, the building would not be left totally without water-supply. Each supply line was five inches in diameter, of extra heavy galvanized wrought-iron pipe; the connections to the street mains were made by means of special connections. Each line had a gate valve at the curb, with a cast-iron service-box, and a T-handle operating rod, so that the supply could be cut off at the street if necessary. The supply lines were cross connected before being connected to the meter. A fish-trap was installed in the line directly in front of the meter. From the meter the lines ran to the filters, which were of the vertical pressure type, built with cast-iron shells. The filters set upon concrete bases, and had

waste funnels which connected with the house drain.

After leaving the filters, the house main had branches to the boiler feed-pump in sub-basement, the cold-water air drum for supplying the lower three stories of the building, the hot-water tank which supplied the three lower floors, and to the suction tank; two other branches were connected directly to the suction pipes of the two pumps, so that in an emergency they could pump directly from the city mains. The house pumps were six-stage turbine pumps, with a capacity of 150 gallons per minute, operated by 25-hp. electric motors.

The suction-pipes of the pumps were connected to the suction tank, and were provided with strainers at the tank to prevent foreign matter from entering the pump. The suction tank was constructed of wrought-iron plates, with the seams rivetted and caulked, and had a capacity of 2,000 gallons. The supply pipe to the suction tank had a reducing manifold header, fitted with four ball cocks. A

two-and-one-half inch pipe was taken from the pumps up to the house tank on the roof; this tank was made of cypress, with a frost-proof cover, and had a capacity of 5,000 gallons. All supply pipes to the tank were thoroughly insulated to prevent freezing. The overflow from the tank and the emptying pipe discharged onto the roof. The tank was equipped with an automatic float switch, which started the pump motors when the supply of water in the tank was lowered, and stopped them when the tank was filled again.

The distributing main from the tank was carried down through the building and distributing branches were taken off at each floor to supply the fixtures on that floor. The main terminated in the basement, and was connected to the hot-water drum which supplied the upper stories of the building. The supply line had a check-valve in the basement, to prevent the water from running back to the street mains.

The hot-water system consisted of two steel drums fitted with a series of U bends

of copper tubing, mounted in parallel, and having steam connections from an auxiliary boiler which heated the Turkish bath during the summer months, and from the main heating system during the winter months. The hoter-water drums were provided with heat regulators which, when the water had reached a temperature of 200 degrees Fahrenheit, cut off the steam supply from the coils, and as soon as the temperature of the water in the drum fell, the valve opened and the steam was again admitted. This prevented overheating the water, which causes steaming at the faucet, and the unpleasant sputtering which accompanies it. The distributing mains were taken off the distributing manifolds, and were carried through the building to supply the fixtures and had circulating pipes running back to the circulating manifolds and then back into the drums.

The hot-water risers and the circulation pipes had expansion loops eight feet long, at the sixth and the thirteenth floors, to take care of the expansion and contraction

of the pipes. The pipes were fastened midway between the loops and allowed to expand both upward and downward. All lines, both for hot and cold water-supply were valved, just above the manifolds, and all of the branch lines were valved so that any line or branch could be cut off without affecting the rest of the system. The valves on all vertical lines were soft seat globe valves, and gate valves were used on all horizontal lines.

The ice-water system was operated by means of an automatic refrigerating machine installed in the basement and operated by an electric motor, controlled by an automatic starter with a thermostatic control. The cooling was done in a cooling tank having a capacity of 700 gallons, a constant level being maintained by means of a float valve. The cooling coils were so placed that the lower pipes were submerged in the water and the return circulation sprayed over the upper pipes. The thermostat, which controlled the temperature of the water, was submerged in the water,

and the operation of the ammonia compressor was automatically controlled by the rise and fall of the temperature of the water. The supply to the tank was taken from the descending main from the house tank.

From the cooling tank, a main supply-line one and one-half inches in diameter was carried up through the building; branches were taken off at each floor to supply the offices, and the drinking fountains in the corridors on each floor. The system was arranged so that there would be no dead ends, and a circulating pipe returned the water to the cooling tank. The cooling tank and all of the pipes were insulated with cork covering made from pure granulated cork pressed into moulds, baked, and then coated with a waterproof finish. When the construction had advanced sufficiently, and the tile floors were laid, the work of installing the fixtures was commenced.

The Turkish bath in the basement was fitted with the necessary shampoos, needles,

showers, and hydrotherapeutic apparatus; and the building was also equipped with stand-pipes, hose-reels, fire-pumps, and other fire protective devices, all of which will be fully described in a later chapter.

The water-closets in the clerks' toilet-rooms in the bank and in the general toilet-rooms throughout the building were of the suspended siphon jet wall type closets, with extended front lips. The closets were supported on cast-iron chair hangers which were set before the tile floors were laid, and the closets were bolted to them through the slabs at the back of the enclosures. The connection between the closets and the branch soil lines was made by means of long lead bends, which gave a flexible connection between the closet and the pipe, and prevented any damage from settlement. This type of closet is undoubtedly the best for use in fireproof buildings, as all piping is kept above the floor-slabs, also the closets are entirely free from the floor, so that they may be easily cleaned under. The seats were of the saddle-hole, open

front and back type. The flushing of the closets was done by means of push-button valves, concealed in the floor, which is one of the most satisfactory methods of flushing fixtures, as the user does not have to touch levers, push buttons or pulls with the hand. All of the urinals were of porcelain with interlocking fronts, which did away with all partitions, and made practically a single unit out of each battery of urinals. The flushing was done by means of push-button flush valves, the same as used in the water-closets.

The lavatories throughout the building were of heavy vitreous china, with integral backs eight inches high, secured to the walls by means of concealed iron wall supports, and having vitreous china standards. The lavatories had "pop up" waste fittings, which are as near fool-proof as can be made. The supplies on the lavatories had crown handle, self-closing, ball-bearing basin cocks.

It is always a good practice in public and semi-public buildings to use self-closing

cocks, as they prevent the waste of water, also the damage which might be caused by leaving the cocks open, overflowing the basin and flooding the room. The crown handle is about the best type of cock for this class of work, as it is practically impossible to fasten it open as can be done with arm, lever, tee, or rabbit-ear handles. The ice-water cocks were of the push-button type, and were set in the backs of the lavatories, which were specially drilled to receive them.

The traps for all lavatories were of the non-siphon type as the city ordinances allowed the use of approved traps of this pattern. The particular trap selected for this work had been thoroughly tested and proven satisfactory, so was installed. Non-siphon traps, which are positive in their seal, are undoubtedly far better than any system of venting as in most cases the vents get closed up at their opening, and do not work after a few months, also the venting of a large number of fixtures makes a maze of concealed pipes, which may eventually

corrode out and become a nuisance instead of a benefit.

All of the porcelain and vitreous ware was inspected to see that no warped, cracked, crazed, nor discolored pieces were included in the shipments, and one or two being found they were ordered sent back to the manufacturers, and perfect pieces sent to replace them. All of the brass pipe for supplies and waste was specified to be iron pipe size; that is, the diameters were to be inside diameters and not outside diameters, as is the rule with brass tubing. All were to be solid drawn tubing of the standard thickness.

When the fixtures were all installed and the plumbing system was complete, the entire system was smoke tested. Smoke testing was done by closing the tops of all of the stacks at the roof, and pumping the system full of a dense pungent smoke produced by burning oakum or oily waste, and forcing it through a rubber hose into the lower part of the system. If there are any leaky or imperfect joints, or any cracks

in the pipes, or fittings, or defective seals in the traps, it is easily detected by the smoke issuing from it. The system tested out perfectly and was accepted, and our work was now practically completed, except for finishing up a few items which will be taken up later.

CHAPTER VIII

ELECTRIC WIRING AND ELEVATORS

THE electric wiring conduit was installed as soon as the reinforcing for the floor-slabs was in place, and before the concrete was poured. This included the conduit for telephone, bell wiring, vault signals, fire-alarms, etc., as well as that for the light wiring. All of the conduit was galvanized, mild steel tubing, which was especially selected with reference to the uniformity of thickness, and each length was required to have the manufacturer's name stamped in the metal and to bear the underwriter's label. No conduit smaller than five-eighths-inch inside diameter was allowed to be used. We were particularly careful to check up all of the dimensions on the plans, to be sure that all of the ceiling outlets were properly located in their relation to the rooms in which they were to occur,

and that the conduit for wall brackets and switches would come in the partitions instead of out in the rooms, as sometimes happens. All cutting of conduit was done with hack-saws, and after it was threaded it was reamed out to remove all burr caused by the cutting.

Bends and offsets in the conduit were avoided as much as possible, and no bends were allowed which had an inside radius of less than three and one-half inches. Once or twice we found the electricians bending pipes in a vise; this was ordered stopped at once, and the crushed pipe was ordered to be removed from the building, and all bending of conduit was thereafter done by means of the conduit bending machines and hickeys, which were provided for that purpose. All conduit was put together by means of standard couplings, no running threads being allowed, and where standard couplings could not be used condulet unions were required to be used, and all joints were made tight with white-lead. All mains were run in the pipe shaft which was pro-

vided for that purpose, and they were secured to the steel beams by means of pipe straps.

Distributing panels were located on each floor, and the conduit runs all started at the panels and had junction or pull boxes located where necessary. Panels were of black enamelled slate, with thirty-ampere knife switches and enclosed fuses mounted in two vertical rows, and cross connected by means of metal strips to polished copper bus-bars running up the centre of the panel. These bus-bars were fitted with lugs at their ends, to which the mains were connected. Panel was surrounded with a one-half inch thick slate frame, or barrier, with opening through which the circuit wires passed to connect with the branch switches. The panels were mounted in cabinet boxes, made from one piece of No. 10-gauge sheet steel, lapped and rivetted at the four corners, with a three-quarters-inch flange turned inwardly all around the outside edge. The cabinet boxes had a four-inch gutter space, in which the circuit wires were carried from

the switches to the ends of the conduit, which terminated in the boxes. The boxes had No. 10-gauge steel doors, lined with slate, and provided with locks to prevent unauthorized persons tampering with the fuses or switches.

The junction, outlet, and switch boxes were of galvanized pressed steel, No. 14 gauge, with knockouts to provide holes for the entrance of conduits. Conduit was secured to the boxes by means of lock nuts and bushings. All of the outlets for lighting fixtures were fitted with insulated fixture studs of malleable iron to screw into the boxes, and the large fixtures in the main corridor had fixture hangers which were independent of the box. All conduit was properly grounded. Grounding was done by bonding all of the separate sections of conduit together, and then grounding the entire system to the water-supply on the street side of the meter. This was done by means of grounding clamps, secured to the pipes, and ground wires attached to these clamps. The ground

wires were of copper No. 10 B. & S. gauge, where the largest wire contained in the conduit was not greater than No. 0 B. & S. gauge, and No. 4 B. & S. gauge when the largest wire contained in conduit was greater than No. 0 B. & S. gauge. The grounded pipes were carefully cleaned of all rust, scale, etc., at the point of attachment before putting on the ground clamps. The conduit for telephone wires was installed on all floors, running from each office to the pipe shaft, up which the telephone company was to run its cables. Also conduit was run under the floors in the various offices with wall outlet, so that bell wiring might be installed by the tenants as desired. The conduit for the vault signals and the vault lighting was installed in the walls of the bank and safe-deposit vaults before the concrete was poured. All of the conduits were plugged as soon as they were installed, to prevent water or dirt entering them during the progress of the work before the wires were drawn.

The current furnished by the local light-

ing company was, as is almost universal throughout the country, alternating current: 220 volt, three phase, sixty cycle, for power, and 110–220 volt, single phase, for lighting; wired three wires 220 volts on positive and negative and 110 volts on the neutral. Two services were provided one for the lighting circuits and the other for the power circuits. The transformer vault was constructed entirely of brick and concrete, with a ventilator through the sidewalk, and provided with a tin-covered fireproof door large enough to take transformers through in case of renewals. Iron sleeves were built into the walls for the conduit to pass through. The feeders were run from the transformers to the switchboard, which was located in the basement in close proximity to the pumps, etc., and handy to the boiler-room, so that the mechanical control was well centralized. The switchboard was made up in two units, one for the lighting circuits and the other for the power circuits.

The switchboard was placed so as to re-

duce the danger of communicating fire to any combustible material to a minimum. It was set out three feet from the wall, so as to be thoroughly accessible from the back, and was designed so that the top of the board was three feet below the ceiling. The board was made up of marbleized slate, one and one-half inches thick. Slate was carefully examined to see that it was entirely free from metallic veins, which might cause short circuits and other trouble. It was mounted in a pipe frame, which was securely fastened to the floor, and braced back to the wall by means of pipe braces, which held it perfectly rigid. The meters were mounted on the switchboard, and it was equipped with all the necessary main switches and circuit switches. All of the switches were three-pole knife switches. Light outlets were located on each board, so that the instrument might be plainly seen at all times.

As direct current was required for the motors for the passenger-elevators, two motor generator sets, one light and one

heavy, for rectifying the current were provided. They were located in the basement convenient to the switchboard, and the feeders were run to them and then run up to the penthouses on the roof, where the elevator machinery was located. As the freight-elevator and sidewalk hoist used alternating current, the feeders were run directly from the switchboard to the motor outlet for these machines. Feeders were also run from the power switchboard to all of the other motor outlets, and terminated in the starting-boxes which were provided for each motor.

The building now being almost completed, and all constructive work finished, the wires were drawn into the conduit. All wire was the best quality annealed copper wire, tinned, insulated with a 30 to 33 per cent rubber covering, and then covered with a protecting braid. No wire smaller than No. 14 B. & S. gauge was allowed to be used, and all wire of No. 8 B. & S. gauge or larger was required to be stranded. All splices in wire were made

in the outlet boxes. The splicing was done by stripping the insulation and braid off the ends of the wires, scraping them clean, and twisting the ends together, making them mechanically and electrically secure without the use of solder, then they were soldered for protection from corrosion, and thoroughly taped with rubber and friction tape. The stranded wire was connected by means of solderless cable connectors and then covered with an insulation equal in thickness to that on the wires. The fire-alarm system was included in the equipment of the building. Fire-alarm boxes were finished in fire-alarm red and bronze, of the break-glass type, and were located in the corridors on every floor. They were connected to the city fire-alarm system by the fire department.

When the interior finish had been put up and the finished floors were laid, the switches, base receptacles, and floor receptacles were installed. The switches in the corridors and other parts of the building which were open to the public were

lock switches; all other switches were three-way or single-pole tumbler switches. The outlets for the base receptacles were wired for a capacity of 300 watts, and the receptacles were of the double type, so that two plugs could be inserted and two fixtures served. The floor boxes were of the water-tight, adjustable type with galvanized cast-iron box bodies fitted with rubber gaskets and water-tight brass covers. When the installation of the wires was entirely completed, each circuit was tested out with a meggar. The testing was done by connecting a wire on one side of the circuit to the binding-post of the meggar, marked "Line," and with another piece of wire connecting a water-pipe to the "Earth" binding-post of the meggar, then turning the generator handle on the meggar, and the resistance of the insulation in ohms was shown on the dial of the instrument. The resistance, in all cases, was found to meet with the requirements of the National Electric Code and the city rules, and the system was accepted.

An intercommunicating telephone system, arranged for selective ringing and selective talking, was installed in the bank. It was equipped with an automatic switchboard, with stations located in the offices, safe-deposit vaults, and all cages and desks throughout the banking-room. The wiring for the telephone system was run in conduits, as before stated, and the wires were stranded cables containing one pair of No. 22 B. & S.-gauge conductors and one pair of No. 16 B. & S.-gauge conductors for talking and ringing batteries respectively. Each pair of wires was twisted and all wires were twisted around each other to eliminate cross talk and induction noises. The wires were of annealed copper, insulated with silk and covered with beeswax as a moisture repellant, and then covered with a lead sheath one-sixty-fourth inch thick; and each pair of wires was of a different color so as to be easily distinguished. The cables were fanned out and properly laced in an orderly manner and secured to the connecting terminals, one of which was pro-

vided for each wire. The batteries were storage batteries, equipped with an automatic charging device, taking current from the light service. The bank and safe-deposit vaults were wired for an electric-alarm service, which will be described in the coming chapter.

The building had twelve passenger-elevators of the one-to-one gearless traction type, one freight-elevator of the single-screw, worm-geared traction type, and an electric sidewalk hoist running from the sub-basement to the sidewalk. The passenger-elevators had a speed of 450 feet per minute for the local cars, and 600 feet per minute for the express cars. The freight-elevator had a speed of 350 feet per minute and a lifting capacity of 4,000 pounds, and ran from the sub-basement to the roof.

The machinery for both the passenger and freight elevators was located in the penthouses on the roof, directly over the cars, with a clearance of eight feet between the supporting beams and the top of the cars. The machines for the passenger-ele-

vators consisted essentially of the motor, the traction driving sheave, and the magnetically released spring applied brake, grouped together and mounted on a continuous heavy cast-iron bed. The motors were slow-speed, shunt-wound motors, specially designed for this service, the brake pulleys and driving sheaves were mounted on the armature shafts which were of high tensile steel and supported the loads. The controllers were located as close to the machines as possible, but allowing enough space between them to work around them.

The machine for the freight-elevator was of an entirely different type, having a multi-groove driving sheave and a non-vibrating idler; the car and counterbalance weight hanging directly from the driving sheave. Drive was obtained by means of right and left hand worm-gears, coupled directly to the electric motor, running submerged in oil, and meshing with two large gear-wheels which mesh with each other, thus giving a three-point drive. Machine was also provided with extra gears, which doubled the

lifting capacity and at the same time reduced the speed to one-half, to be used when required for lifting safes or other heavy loads. Heavy iron clips were fastened to the main guides at each floor, which, when tightened up, held the car level at the floor when taking on or taking off heavy loads. The cast-iron brackets for supporting the guides for cars and counterweights were put in place as soon as the steel frame was erected, and the guides were then installed. The main guides were planed steel tees, 5 by 3½ by ⅝ inches, reinforced with 7-inch channels, bolted to the tees every 6 feet by means of two ⅝-inch tap bolts. The ends of the tees were tongued and grooved to form matched joints. The counterweight guides were 3½ by 2 7/16 by ⅝-inch tees.

The passenger-elevators had steel pans at the foot of the shaft, giving a clearance of eight feet at the bottom, with oil cushion buffers, one under the car and one under the counterweight, which were arranged to bring either the car or the counterweight

to a gradual positive stop through the displacement of the oil in the buffers. The car slings, which are the frames holding the cars, were made up of structural steel channels, reinforced with steel gusset plates. The platform sat in the slings and consisted of angle-iron frames, with wood filler pieces one and three-quaters inches thick, and a seven-eighths-inch maple underfloor; the under sides of platforms were covered with No. 18-gauge sheet metal for fire protection. The passenger-cars were made of furniture grade sheet steel, panelled, with grill work on top; all enamelled to match the steel trim used throughout the building. The floors in the car were of cork tile.

The hoisting cables were a six-strand, nineteen-wire, mild steel hoisting rope, made especially for use on traction-elevators, where, on account of the quick starting and stopping, a stronger and lighter rope is required, and it is also more flexible to the strand for double wrapping. The cars were suspended from one end of the cables and the counterweights from the

other end; they passed partially around the driving sheave, continued around the idler leading sheaves, thence again around the driving sheave, thus making a complete loop around the sheaves. The hitches on the car and counterweight cables were of the self-adjusting type, with a thimble rod for each cable, at the end of which was an adjustable socket which turned with the twisting of the rope and prevented the loosening of strands. The cables were babbitted into the sockets. Each car was equipped with a compensating rope device consisting of a sliding sheave frame in the bottom of the pit, around which travelled the compensating rope, which ran from the body of the car to the under side of the counterweight frame; the object of this being to cancel the weight of the hoist on the long hoist in a high building. This does away with the rattling chain which we all know so well.

The counterweight frames were composed of two channels rivetted together by means of steel plates, the weights being of

cast iron, so formed as to set into the flanges of the channels, and tied together by means of three-quarters-inch steel rods. Counterweight screens were placed at the top and bottom of the shafts; they were eight feet high, made up of steel plates and angles, and bolted to the counterweight guides. Each car and counterweight had four self-adjusting guide shoes, two at the top and two at the bottom, having bronze gibs or shoes, which were held close against the face rail by means of heavy springs, thus eliminating the wear on the body of the main guide shoes. On each of the top guide shoes was fastened a positive type lubricator, consisting of an aluminum box that fitted snugly around the face of the guides. This box being filled with oil, lubricates the guides by the action of a felt-wick feed. This does automatically what formerly had to be done by hand, and saves the old tedious job of greasing slides, and also allows the use of oil instead of grease for a lubricant, with the consequent cleanliness. The safeties

were located on the safety channels under the cars, and were of the wedge-clamp type and were operated by a two-ball governor which was set to a variation of five degrees above and below the car speed. These governors were located at the top of the hatch, and acted in the same manner as the common type of engine governor; when the balls fly out from excessive speed the governor rope is tripped, releasing the drum which controls the action of the wedges, which sets the clamps on the guide-rails.

The operating switches in the cars were of two-speed regulation, and had approximately six contacts, three to each side; two of these are for the common feed to the car switch, two for the reversing switch, and two for the fast and slow speed switch. In addition, the cases of the car switches were equipped with a rack emergency device, operated by a hand wheel, in case of the switch becoming inoperative. A complete signal service was installed in the cars and on the floors, the controlling mechanism of which was located in the pent-

house on the roof, a motor generating set being provided there for rectifying the current. "Up" and "down" push-buttons were conveniently located on each floor; a signal-light in the car was lighted a floor and a half in advance of the car's arrival at the landing at which the button was pushed. In addition, the pressure of the push-button caused the signal-light in front of the approaching car to be lighted, and show which car would serve the passenger. The passenger signal was lighted three floors in advance of the car's arrival, which gives the passenger time to reach the proper doorway before the car arrives. Both of the signals are automatically extinguished when the car reaches the floor from which the call was made.

There was a transfer switch located in each car, so that if the car was loaded to capacity the operator could transfer the signal to the next approaching car, and the passenger would not have to press the button the second time. The cars were also equipped with illuminated thresh-

olds, which contained two tubular electric lights, the lights showing through a number of glass lenses inserted in the top and front of the platforms, the current for the lights being taken from the lighting fixtures in the cars. The sidewalk hoist was a drum-type worm-geared machine, with a speed of 50 feet per minute, and 3,000 pounds' lifting capacity, operated by means of a hand rope. The car has an overhead frame for opening the sidewalk doors, and an automatic bell signal to warn persons standing on the sidewalk doors of the approach of the car.

When the installation of the elevators was completed and ready for acceptance, they were thoroughly tested out by the elevator company's representatives in our presence to see if they came up to the requirements of the specifications. The first test which was made was to see if the car would lift a specified load at the specified speed. One of the speed points was marked six feet above the bottom landing, the other about six feet below the top landing; a

piece of paper was fastened at each point and the distance between the points was carefully measured. Then the car was started from the first floor with the speed load, and the time required for the car floor to pass the speed mark was noted with a stop-watch. This determined whether the speed-load duty had been fulfilled. Then the maximum load was placed on the car, and the speed was taken as before. The cars were required to lift the maximum load at a speed within 30 per cent of the speed specified in connection with the speed load. With the maximum load on the car the speed up and down was taken to see that the down speed did not exceed the up speed by more than 15 per cent, with the controller in full-speed position.

After each test the motors were examined to see that they had not heated, and that all parts of the machine were working smoothly. We rode up and down in each car, and saw that there was no objectionable side or end play on the cars nor any disagreeable grinding of the cars and coun-

terweights. The drop test not being practicable, speed tests were made by speeding up the motors by inserting resistance in series with the shunt field. A hand rheostat of a capacity to carry the current, and connected in series with the shunt field, was employed, starting up the machine with all the resistance in this rheostat cut out. The resistance in the shunt-field circuit was cut in and increased the motor speed sufficiently to trip the governors which operated the safeties. The automatic terminal-stop mechanism was tested by running the cars at full speed into both limits of travel with the controller held over to full-speed position. All of these tests having proved satisfactory, the elevators were then put in charge of the regular operators and the service in the building was commenced.

CHAPTER IX

BANK VAULTS AND FIXTURES

WHILE the work which has been described in the preceding chapters was going on, the work of installing the bank vaults, counters, and screens was progressing rapidly. The concrete foundations and walls of the safe-deposit and bank vaults was poured with the other concrete. The vaults were designed by a vault engineer, and the construction was superintended by him, but in his absence we were intrusted with the supervision of the work, and acted in concert with him at all times. The walls, floors, and roof of the vaults were constructed of concrete, with rail reinforcement, as described in Chapter II. It was intended to render the vault as nearly fire, burglar, and mob proof as was possible.

In the larger cities the danger from burglars has been reduced to a minimum by

efficient police protection and private watch systems. Also, the famous old-time cracksmen of the "Shang" Draper and "Jimmie" Hope type have been entirely supplanted by the "yegg," who preys upon the small-town banks, so that the greatest danger which may have to be combated in any of the larger cities is the one of mob violence, more than that of the night prowlers, so that the vaults must be made to withstand all manner of onslaughts by high explosives, drilling, the oxyacetylene blast, blau-gas cutter burner, or the electric arc, of which any one or more may be used. And, although the burglar risk is reduced greatly, still "eternal vigilance is the price of safety"; and burglaries still continue to occur in all of the larger cities, and corporations and firms handling large sums of money have their safes blown open, or ripped open, quite regularly between Saturday night and Monday morning, so bank equipment must still be calculated to withstand the attack of burglars as well as that of the mob.

The vaults were lined on all four sides and the top and bottom with plates four inches thick, made up of layers of electric-furnace abrasive grains, combined with iron, which had been proven to be as nearly drill and cutter burner proof as any material could be, having a greater resistance than laminated plates, or any other form of lining at present known. The doors were single straight flange doors, thirty inches thick. The joints between the door and the jambs were carefully and accurately ground, so as to make a positive mechanical seal. The doors were built up of a composite construction. The outer shell was of cast low steel, inside of which was a concrete section, which was reinforced with jail rods, which were saw-proof and file-proof. The bars were set both horizontally and vertically, four rows of bars being used. Inside of this was a six-inch tool and cutter burner resisting plate, of the same material as was used for the lining of the vaults. This plate had a one-inch layer of one-half-inch abrasive grains on

each face, and a two-inch layer of one-inch grains through the middle. On the inside of this section was a facing of laminated steel construction on which was mounted the cast-steel bolt frame, the bolt mechanism, and the time locks, which were located in a centre drum, housed in a steel case, and having a cover door. The doors were hung on crane hinges, with wheel-operated pressure mechanism.

The combination locks and the bolt-throwing mechanism was located on the jambs of the doors. All of the mechanism, bolts, etc., was draw-filed steel. The combination-lock dial was set on the pressure mechanism housing on the door-jamb, and had a steel cylinder set angle-wise and provided with an oval glass window, set eight inches from the illuminated stationary dial, provided with two revolving pointers, each of which was connected with the combination locks.

Lowering platforms with controlling hand wheels were placed in front of the doors, so that a level passage could be had

into the vaults. The vaults were also provided with emergency doors of a smaller size, but of equally efficient construction, which were to be used in case of lock-ins or other emergencies, but in no way affecting the security of the vaults. The bank vault was fitted up with steel security and coin lockers, with steel doors fitted with two combination locks. The safe-deposit vault was fitted up with safe-deposit boxes, the minimum size having a unit width of five and one-half inches and an outside depth of twenty-six inches.

The boxes were fitted with locks which were provided with a guard key, which was in charge of the custodian, and was common to all of the locks in a series; each lock also had its individual key, which fitted only its own lock, and differed from every other key in the series, these keys being known as the change keys. Before the change key could be inserted, or used in its lock, the guard mechanism had to be unlocked by means of the guard key in charge of the custodian. The safe-deposit vault was provided with

a bronzy day gate, which had a latch lock which could be opened only by means of a key.

A bed of cement mortar one inch thick trowel-smoothed, was laid over the floors of the vaults. On this was laid a finished floor of cork tile 6 inches by 12 inches, one-half inch thick. On account of its resilient quality, and its comparative noiselessness, this makes an admirable floor for vaults. The vaults were wired for lighting, telephone, and electric fans, all of the wiring being permanent and built into the walls, floor, and ceiling as the vaults were being constructed.

Both the public and the intercommunicating telephones were connected with the interior of the vaults, so that direct communication could be had with the outside by any one locked in. Safe-deposit vault had a switch in the vestibule with momentary contact button, actuating the automatic switch; also, the vaults were provided with receptacles for attaching portable lights, and they had continuous burn-

ing night-lights for emergencies. As an extra precaution, the vaults were wired for an electric alarm system. The four side walls, the floors, and the roofs of the vaults were surrounded with lead-covered cables, spaced four inches apart, and run both longitudinally and transversely, and terminating in a junction box, which connected with a conduit which ran to the telephone service, to be connected with the police signal system.

A system of panelled doors, similarly wired, were installed on either side of the vault doors, closing over them, and protecting them. This system was on a closed circuit and the breaking or cutting of any one of the wires would give an alarm. The wiring was covered over with marble panelling, which was set so that it was easily accessible in case of repairs, which might be made necessary by any break in the system.

The counter fronts were built up to the level of the counter tops with walls of hollow tile four inches thick. In these walls

were set steel angle standards, which were securely bolted to the floors, and which formed a rigid support for the bronze screen work, which was above the counters. The outside face of the counters was faced up with marble, with moulded base course and cap mould, all anchored back to the tile walls by means of brass-wire anchors. The marble which was used above the base was Italian Pavanozza. On account of the extremely fragile character of this marble, all of the slabs were backed up with slabs of hard, sound, cheap marble, the backing and the face being set together with plaster of Paris, which insured a perfect adhesion between the two slabs. We examined all pieces of marble to see that no fractured pieces were used, and that none of the pieces were dowelled along the line of a fracture, which is sometimes done with this marble.

The screen work above the counter tops was of bronze and plate glass. The pilasters, cornice, frames, grills, and wickets at the various windows were of cast and

wrought bronze. A continuous reflector, which was set in a drawn bronze frame, ran around the inner side of the cornice, forming the finish. The reflectors were carried along the tops of the partition screens, and formed a cornice over them, giving light to the desks on both sides. The backing of all the screen work and the cap plates of all the partitions was No. 16-gauge cold-drawn bronze; all of the bronze work in the screens was the highest class architectural bronze. All of the ornamental work was cast from carefully modelled patterns; where five or more castings were to be made from the patterns, metal master patterns were used. These patterns were cast from the plastic models, and were then finished by hand-chasing. Where not more than four reproductions were to be made from a pattern, the moulds were made directly from the plastic model.

All of the castings were rechased from a chased master pattern. All of the exposed surfaces of the moulded and plain work

had the fire skin removed by filing or grinding, and brought to a true surface and finished with a drawfile ready for coloring. All of the bronze work was put together in a most approved manner, by means of concealed screws and rivets. All of the framing, blocking, reinforcements, screws, and connections were of bronze, or other non-rusting alloy, and where the bronze work was attached to the steel framing, it was bushed with bronze or copper, and the connections were made by means of bronze bolts and rivets. No work the face of which formed a finished surface was allowed to come in contact with the steel framing. All of the steel framing was given two good coats of graphite paint before the bronze work was erected.

All of the glass used in the screens was a non-shattering glass, which was made up of two pieces of polished plate glass, with a sheet of celluloid between them and welded together under a high temperature and a tremendous pressure. This glass will not shatter or fly when struck by any

ordinary missile, strong impacts merely causing a multitude of hairlike cracks, but no breaks or flying splinters. The glass was held in place by means of stops formed of rolled-bronze channels, held in place by means of oval-headed bronze machine-screws.

The tellers' cages were framed up of bronze tubing, one and one-half inches square at the angles and corners, with roof framing of ⅜-inch by 2½-inch bronze bars; the panels were filled with one-and-one-half-inch mesh. The finishing of the bronze work was done by first cleaning it by dipping in a solution of sulphuric acid and water, then washing thoroughly, and oxidizing with a solution of sulphate of ammonia, and rubbing it down to an even color with pumice-stone, and finally given one coat of white wax, thinly and evenly brushed on.

The tops of all the counters were formed of two-inch-thick slabs of structural glass, making a smooth, impervious surface. The space under the counters was filled in with drawers and lockers made up of furniture-

stock sheet steel, finished in enamel. The drawers had slides with antifriction-bearing surfaces, and all of the cases were completely closed at the bottom with steel shelves to keep out mice and vermin. All of the desks, filing-cases, etc., were made up of sheet steel in the same manner. The dressing-rooms for the clerks and the officials were fitted up with steel wardrobes provided with hat-shelves, bronze coat-hooks, umbrella-holders, and drip-pans.

With the installation of the lighting fixtures, which were of bronze of an ornate character, the work of fitting up the banking-room was completed, except for the installing of the movable furniture and the rugs in the president's and directors' rooms, and the rooms for the women customers, which does not come in the construction, so need not be described.

CHAPTER X

HEATING AND VACUUM CLEANERS

ALTHOUGH no mention has been made so far of the heating apparatus, it has not been forgotten nor neglected. As the construction work progressed the steam mains, risers, and returns were installed. The boilers were set early in the progress of the work, being delivered at the building before the steel frame was erected, and were placed in the sub-basement before the floor beams were set. The heating of the offices, corridors, etc., was done by a vacuum system of heating, using low-pressure steam.

On account of the large amount of radiation required, steel boilers were used. The boilers, three in number, were of the horizontal return tubular type, two being used for heating the building, and the third being held in reserve. A small auxiliary high-pressure boiler for heating water and

for supplying heat for the Turkish bath was also installed. The boilers were sixteen feet long and seventy-two inches in diameter, which gave a length of a little over two and one-half diameters, which is the ratio generally recommended in good boiler-making practice. The tubes were of standard thickness, four inches in diameter, which gave them a length of forty-eight diameters, which is the maximum length which should be used. The boilers were made up of special high-grade steel, tested to sustain a tensile stress of 60,000 pounds per square inch, and each plate was so stamped. The boilers were rivetted in the best manner, all longitudinal seams being butted, double-strapped, and triple-rivetted, the vertical seams and the flanges of the dome were double-rivetted. The edges of all sheets were planed and bevelled before the sheets were put together, and all of the seams were caulked with round-nosed tools.

The shells of the boilers under the domes were not cut away, but were perforated to

afford the free passage of steam and drainage. The boilers were thoroughly braced with crowfoot braces, made of refined steel. A manhole 11 inches by 15 inches was placed in the top of each boiler, and handholes were provided in the heads of the boilers. Each boiler had three heavy cast-iron lugs on each side, which set upon 12 inches by 12 inches by 1¼ inches cast-iron plates, set in the brick setting. The two rear bearings were roller bearings, to allow for expansion. The boilers had full sectional cast-iron fronts, with double doors opposite the tubes, and feed and ash-pit doors. All of the ironwork was extra heavy and well bolted and screwed together, and finished with pilasters and cornices.

As the boiler-room was below the bed of the old stream which was on the site, and there was considerable liability of the boiler pit being flooded, the boilers were placed in a water-tight steel pan. This pan was three feet deep, and wide enough to accommodate all of the boilers, and of sufficient length to allow room for firing; it was made up of

one-quarter-inch plate, reinforced with steel angles and tees, but so constructed as to present an unbroken floor surface. Three-inch pipes, which were as long as the pan was deep, placed so as to come between the boilers, were flanged to the bottom of the pan, to give an air relief, so that the water pressure would not lift nor buckle the pan.

The boilers were set with walls of hard-burned brick, laid up in cement mortar. The side and rear walls were eighteen inches thick, which included a two-inch air space, the centre walls were twenty-four inches thick, and the bridge walls were twenty-four inches thick at the top. The walls were provided with six-inch steel I-beam buckstays, with tie bolts and anchor rods. The tops of the boilers were levelled off with porous terra-cotta blocks, four inches thick, supported on steel tees set thirteen inches on centres. The walls of furnace, bridge walls, and the back connections were all lined with fire-brick laid in fire-clay. The fire-brick were laid up dry, and the fire-clay was mixed to the con-

sistency of thick soup, and the brick were dipped in the clay and then laid in place, and well hammered down, so as to get the thinnest possible joints. The ash-pits under the boilers were paved with hard paving brick, laid on edge and thoroughly grouted with cement mortar.

Each boiler had a separate smoke flue, so placed that the fire gases passed under the boiler shells, then forward through the tubes, and then across the front through the vertical flues, which connected with the main flue, which was increased in size for each boiler-flue connection. The smoke flues and connections were made up of No. 10-gauge wrought iron, rivetted, with three-eighths-inch rivets, with three-inch pitch, all of the connections being made perfectly tight. The flues were supported by means of wrought-iron hangers, fastened to the steel floor beams above the boiler-room. Each flue was provided with cleaning doors, and had a pivoted hand damper, and the main flue had a damper regulated with an automatic damper regulator. The

flues from the boilers and the main flue were covered with No. 26-gauge, galvanized metal lath, securely fastened to steel angle framework, which was built around the flue, and then plastered with two inches of magnesia covering. The boiler flue connected with the chimney stack, which was made up of three-eighths-inch steel plate, rivetted with five-eighths-inch rivets, with four-inch pitch, all joints being caulked and made gas-tight. The flue was built up in twenty-foot sections, and it was erected in conjunction with the steel framing. Each section of the flue was supported by means of two six-inch I-beams, bolted to the floor beams. A horizontal section with an outlet flanged with 3-inch by 3-inch angles extended into the boiler-room and was connected to the boiler flue. The stack had a clean out, with a hinged door at the bottom.

The boilers had three-inch blow-off cocks and valves, and blow-off pipes to the blow-off tank. The blow-off pipes were extra heavy pipe, to resist any sudden

stress which might be liable to occur in them. The blow-off tank was 3 feet in diameter by 6 feet long, with a manhole at one end. The shell was constructed of best open-hearth iron, five-sixteenths inch thick, and the heads were of flange iron, three-eighths inch thick. The tank was rivetted, caulked, and braced, and had a drain-pipe connected to the house drain outside of the vault wall, and it was also provided with a vapor pipe which was carried up ten feet above the main roof, and capped with a galvanized-iron exhaust head. A cooling coil was installed in the tank, connected with the water-supply and with the discharge pipe. Each boiler was equipped with a two-inch feed valve, with stop and check valves, and had a combination water and steam gauge with try-cocks, and brass safety-valve, with lock-up attachment.

The steam distribution was accomplished by means of a down-feed system of piping. The main supply was taken from the steam header over the boilers, and was connected

with the rising main, which ran up to the ceiling space over the twentieth story. The riser had an expansion loop located at the tenth-story ceiling. The loop was so constructed that all of the movement caused by the expansion of the pipe was taken by the turning of the pipes in the fittings, and no strain was placed on any part of the piping. The expansion loop was hung at the far end in an adjustable wrought-iron hanger secured to the steel floor beams. The riser was anchored to steel framing at the fifth and fifteenth floor levels, by means of adjustable pipe anchors. From this main riser a series of distributing mains, hung from the roof beams by means of adjustable expansion hangers, were run above the ceiling, to feed the down-feed risers.

All of the pipe used in the heating system was standard lap welded, puddled wrought-iron pipe, and all fittings were standard cast-iron fittings. The fittings on the boiler header, the main feed line, and the main riser were standard cast-iron flanged

fittings, with companion flanges on the pipe, and they were put together with copper gaskets. The ends of all pipe were reamed out to remove all burr caused by cutting. Before installing the pipe each length was stood on end and pounded, to remove all loose scale, dirt, rust, etc. The use of red-lead, or pipe cement, in the joining of pipe and fittings was not allowed, joints having to be screwed up and made tight, without the use of these materials.

The connection from each boiler, of steam header, the main supply, the main riser, the distributing mains, and each down-feed riser were valved. The valves in all of the horizontal lines were gate valves. All valves over two inches in diameter had iron bodies, with steam metal mountings, and all valves of two inches diameter or under were of steam metal. The down-feed risers were run from the distributing mains down to the second floor, decreasing in size as they descended. The return lines started at the twentieth floor and ran to the sub-basement, increas-

ing as they descended. Wherever the pipes ran through the floor, they were fitted with nickel-plated, hinged, floor and ceiling plates.

The radiator run-outs were taken off the risers above the floor, and care was taken to see that they were pitched toward the riser in all cases, and that there were no sags nor pockets to cause trapping. The radiation in the corridors, brokers' offices, and minor rooms on the first floor and basement was supplied by an up-feed system, taken off the main steam supply, the returns being taken into the main return line. All of the radiators throughout the building were plain cast-iron hot-water pattern radiators, the difference between steam and hot-water radiators being that steam radiators have both the supply and return tappings at the bottom, whereas hot-water radiators have the supply tapping at the top, and the return tapping at the bottom. This type of radiator is preferred for vacuum systems of heating. All of the radiators were thoroughly washed out

at the foundry to remove all core sand and other foreign matter. The air-vent tappings were plugged with permanent iron plugs, and the supply and return tappings were plugged with wooden plugs, which were not allowed to be removed until the radiators were ready for connecting up. The radiators had modulating valves on the supply end, which allowed a regulation of temperature by the controlling of the circulation of steam, by throttling the inlet on each radiator.

The vacuum traps on the return ends of the radiators were of the sylphon type, operating on the thermostatic principle, using a sylphon bellows made up of a multiple construction of seamless brass folds. These traps allowed the free passage of air and water, but were closed by the action of heat and prevented the leakage of steam. The return lines were connected to the return main in the sub-basement. This line was graded in the direction of the flow of the condensation, and ran to the vacuum-pump. A suction strainer was provided

between the suction end of the pump and the end of the line, to prevent dirt and scale entering the cylinder of the pump. The supply line and the main riser were dripped into the vacuum return line, and they were provided with gate valves, dirt strainers, and sylphon traps. The vacuum-pumps were electrically driven, direct-connected, rotary-pumps, with automatic float control switches. An air-separating tank for eliminating the air from the condensation was placed between the vacuum-pumps and the boilers.

The heating of the banking-rooms and the safe-deposit department in the basement was accomplished by means of an indirect system of heating, with a fan and air washer, and fitted with a temperature-regulating system. The apparatus was located in the sub-basement. The fresh air was taken through the intake into the fresh-air chamber, which was made as nearly air-tight as was possible to prevent taking air from the interior of the building. The fresh-air chamber was connected with

the tempering coils, which were made up of one-inch wrought-iron pipes, in four-row sections, set into a cast-iron base, which was connected with the steam header. These coils were incased in galvanized sheet casings, firmly braced with steel angles. The air washer adjoined the tempering coils. This sat on a tank made up of No. 14-gauge sheet iron, braced and rivetted to a galvanized-steel angle frame, with all seams and rivet heads soldered over to make them water-tight. The upper casing was of galvanized sheet iron, braced with galvanized-steel angles, and all seams and rivet heads soldered over as in the tank. The principal features of the air washer were the diffuser plates on the intake side, which were of heavy-gauge galvanized iron plates; these served the double purpose of evenly distributing the incoming air and maintaining an even velocity through the spray chamber, and preventing any back splash of atomized water from the spray chamber. The bottom header risers and spray nozzles were placed

in front of the diffuser plates, which gave a body of atomized water, through which the tempered air passed, was humidified, and all dust, soot, etc., removed. At the discharge end of the washer were the eliminator plates, which removed the entrained water from the air. These were placed in tiers and a spray pipe was arranged to flood them and keep them washed and cleaned.

The air washer had a direct-connected, motor-driven, centrifugal recirculating pump, and the tank was provided with strainers of fine copper mesh to prevent the dirt which was washed from the air from reaching the pump and the spray nozzles. The tank had an overflow trap and drain to the sewer, and a valved waste was located in the bottom of the tank for emptying purposes. The fan was of the multivane, direct-connected, motor-driven type, with a speed of 425 revolutions per minute. It was set in a sheet-steel housing. The discharge of the fan connected with the heating coils, which were of the same construction as the tempering coils,

and set in a galvanized sheet-steel casing, which was connected with the ducts. The returns from the tempering coils and the heating coils were fitted with vacuum traps with thermostatic disks, and were connected to a special return main connected with the vacuum-pumps. Individual ducts ran from the heating chamber to the various outlets in the basement and the first floor. Where the horizontal branches in the sub-basement connected to the riser ducts and flues, especial care was taken that there should be no abrupt turns, all of the curves having a long inside radius.

All ducts and flues were built of galvanized sheet steel. Where one dimension was forty-eight inches or over, No. 20-gauge metal was used, and they were braced with steel angles. Where one dimension was thirty inches or over, No. 20-gauge metal was used, and where they were twelve inches or over, No. 22-gauge metal was used. The ducts were made with slip joints, presenting a smooth surface in the direction of the flow of the air. Each duct

was fitted with a mixing damper, controlled by a pneumatic thermostat located in the room to which the ducts lead. These thermostats were supplied with compressed air from a small hydraulic air compressor located in the sub-basement. The compressed air was carried to each thermostat by means of a small pipe concealed in the wall, and a branch pipe connected the thermostat with the damper. The registers were placed in the walls, and in the front of the marble bank screens, boxes being provided at the ends of the duct for attaching the registers, which were of cast bronze, finished to match the bank fixtures. All register boxes were closed up with boards until the completion of the building, to keep out dirt and rubbish.

When the system was completely installed, all of the exposed piping in the basement, the main riser, and the distributing mains were covered with sectional magnesia covering, all fittings and flanges being covered with magnesia blocks and magnesia plastic, smoothly trowelled. The

coverings were finished with an eight-ounce canvas jacket, put on over heavy sheathing paper, and well sewed with approximately three stitches to the inch, and held by means of japanned bands, and then given two good coats of lead and oil paint. All pipes and fittings which were not covered, and all hangers and other ironwork, including the boiler fronts, were painted two coats of best black Japan varnish. All radiators and all of the exposed piping was given a coat of yellow ochre, and a coat of special primer, and bronzed with liquid bronze, except in the toilet-rooms, where they were enamelled with white radiator enamel.

Before turning the system over to the owners, the contractor tested it out thoroughly in our presence. The boilers were tested by the makers before delivery to a hydrostatic pressure of one hundred pounds to the square inch. The boilers were filled with water, and the entire system was started under pressure, to clean it out. The condensation was allowed to waste into the

sewer, instead of returning to the boilers, a globe valve being provided under the strainer for that purpose. This was continued for several days, until the system was cleaned of grease and dirt. Then the safety-valves were temporarily reset, and the pressure was run up to fifteen pounds, and kept there until all piping, joints, valves, and connections could be examined, and those few which we found defective were made tight; one or two radiator sections were found to be cracked and were replaced by perfect ones. The boilers were blown off and the interiors of the sylphon traps were removed and the traps were thoroughly cleaned. The vacuum-pumps were then started, and the vacuum control was regulated to start the pump at from two to three inches of vacuum, and to stop the pump at from five to six inches of vacuum.

A vacuum-cleaning plant was installed. Two four-sweeper cleaners with two risers each were installed. By four-sweeper cleaners it is meant that four sweepers can

be used at the same time. The piping for the vacuum cleaners was installed at the same time that the steam piping was installed. All of the pipe was standard-weight, black wrought-iron, screw-jointed pipe, smooth on the inside, and free from dents, kinks, fins, or burrs, and all fittings were cast-iron recessed drainage fittings. The ends of all pipe were squared and reamed smooth, and the threads were cut so that the pipe would screw into the fittings in such a manner as to leave a practically smooth passage through the pipe and fittings. Brass clean-out plugs were installed at the base of all risers, and they were set so that they pointed in the direction of the flow of air. All horizontal pipe was supported by means of adjustable pipe hangers, spaced not less than ten feet apart, and all risers were secured to the steel floor beams. The inlets were of nickel-plated brass, with self-closing covers, and they were placed in the baseboard in all cases, and were so located that a fifty-foot length of hose would reach to all points, and each

cleaning radius overlapped the adjoining radius.

The cleaners were located in the sub-basement. The exhausters were of the centrifugal fan type, with ten horse-power motors direct-connected to the shaft of the fan. A five-inch exhaust pipe was run from each cleaner, and was carried overhead on the sub-basement ceiling into the pipe shaft, up to and through the roof, and fitted with a galvanized-iron exhaust muffler. The motors were provided with seventy-five-ampere double-pole, single-brake knife switches, one double-pole circuit breaker, and starting rheostats of proper capacity to control the motors. The cleaners had dust separators to prevent dirt and dust from passing through the vacuum producers.

After the cleaners were installed they were tested out as follows: All of the piping was subjected to seven and one-half pounds' air-pressure, to determine the tightness of the system. We then had an operating test made by selecting four out-

lets, two on each riser, to which was attached one hundred feet of hose of the size which was to be used on the system, with the ends open. The exhauster was required to maintain the specified vacuum when running at or under the specified speed, and the power consumed was not to exceed fourteen kilowatts. As a test of the tightness of the whole system and the effectiveness of the vacuum control, the exhauster was run with all outlets closed and the power consumed was not allowed to exceed 50 per cent of that at the full load.

A final test was made of the separators. We selected four convenient points near four outlets, two on each riser. The contractor then spread on the floor, evenly covering the surface, on four spaces seven feet square, a mixture of twenty-four pounds of dry, sharp sand, that would pass through a fifty-mesh sieve, twelve pounds of fine wheat flour, and four pounds of finely pulverized charcoal. Fifty feet of hose was then attached to each of the four outlets, and all of the surfaces were cleaned

simultaneously. When all of the sand, flour, and charcoal had been taken up, the exhausters were stopped, and the dirt was removed from the separator and spread upon the floor again, and the operation was repeated until the floor had been cleaned four times. On the completion of this test the cleaners were examined, and more than the required 95 per cent of the dirt removed was found in the separators, so the system was accepted and it was turned over to the owners' employees to be operated.

CHAPTER XI

INSTALLING OF FIRE PROTECTION AND FITTING UP TURKISH BATH

DESPITE the fact that the building was of a strictly fire-resisting construction (practically no wood being used except for the cabinetwork in the first story), the furniture and the contents of the offices was most of it combustible, therefore some fire protection was necessary. The local ordinances required stand-pipes in all buildings over four stories in height, and by making these and all of the equipment comply as nearly as possible with the regulations of the National Board of Fire Underwriters, low insurance rates on both the building and its contents was made possible. Four six-inch stand-pipes were located in the corridors and stair towers, so arranged that any point on any floor might be reached with a fifty-foot length of hose.

The supply for the stand-pipes was taken off the discharge end of the fire pump, and it was cross-connected so that either the fire pump or the house pump, or both pumps could supply water in case of fire. The stand-pipes were of extra-heavy galvanized, puddled wrought-iron pipe, with extra-heavy cast-iron fittings.

A steel tank made up of one-quarter-inch plate, thoroughly rivetted and caulked, and set up fifteen feet above the roof on steel supports, kept the stand-pipes full of water and provided a temporary supply until the pumps could be started. Branch lines were run from the supply line for stand-pipes, through the basement walls on both streets and terminated with Siamese-twin connections on the sidewalks, through which water from the street hydrants or the fire-engines could be forced into the system. These Siamese connections were of brass, with two-and-one-half-inch outlets, fitted with couplings the same as those used by the local fire department. They were fitted with swinging flap valves, which

closed one opening when the pressure was applied to the other and stood open when water was forced through both openings. The caps on the Siamese connections were of galvanized iron, on account of the liability of brass caps being stolen.

The pipes for these sidewalk connections were fitted with iron body, soft seat, straight-way swinging check-valves, which prevented the water which was supplied from one source being lost through the other outlets. Another check-valve in the line connected to the tank prevented the water from filling and overflowing the tank when the lines were supplied from the pumps or the Siamese connections on the sidewalks, and a check-valve was placed in the pump pipe to relieve the pump valves of the pressure of the water in the system.

The system was provided with emptying pipes three-quarters of an inch in diameter to drain the entire system, and drip-pipes were provided to empty and prevent water freezing in the pipe between the check-valves and the Siamese connections

on the sidewalks. Two-and-one-half-inch outlets were provided on each stand-pipe in the basement and in each story of the building, fitted with quick-opening, gate-type hose valves. The stand-pipes had a short horizontal line directly under the roof, with a gate valve in the line, with a long stem, the wheel handle being placed above the roof. From the horizontal line a riser ran through the roof, and was fitted with a two-and-one-half-inch hose connection. A drip-valve with a three-quarters-inch drain line was placed at the bottom of this riser. Each stand-pipe was fitted with a gate valve, placed just above the ceiling. This valve was kept strapped open. All of the valves used on the stand-pipes had Babbitt metal seats, which allowed them to close tighter than those having hard metal seats and prevented any leakage of water.

The hose-valves on each story terminated in hose cabinets, which were set in the walls and finished flush with them. These cabinets were made up of No. 18-gauge

steel, with frames and doors formed of No. 14-gauge steel, all finished in baked enamel, which matched the steel trim throughout the building. The doors had plate-glass panels, and they were fitted with bullet catches and pull-handles. Inside of the cabinets were swinging hose racks, each one fitted with fifty feet of two-and-one-half-inch Underwriter's unlined linen hose, with an Underwriter's play pipe. This play pipe was of aluminum bronzed iron, as brass play pipes are constantly being stolen in public buildings, thereby rendering the fire protection ineffective. Unlined linen hose was used in preference to rubber-lined hose, as it is not affected by heat, is much lighter, occupies very much less space, does not require testing, does not deteriorate, and also it costs less. At each hose connection on the roof was set a fireproof hose-closet, made up of No. 20-gauge corrugated iron, with a steel angle frame, and fitted with slatted shelves and a rain-proof door. This closet was provided with fifty feet of rub-

ber-lined cotton hose, one Underwriter's play pipe, a Tabor pattern spanner, a lantern, a fire-axe, and a pick. The hose-closet was painted one coat of red-lead and oil, both on the inside and the outside, and then painted two coats of white-lead and oil of a gray shade.

The fire pump was located in the sub-basement, and was a three-stage turbine-pump, with a capacity of 500 gallons per minute, direct-connected to a seventy-five horse-power electric motor, with a gasolene-engine at the opposite end of the shaft, so that in case of any trouble with either the motor or the wiring, the coupling-pins could be removed from the motor coupling placed in the opposite end and the pump operated by the engine.

The building was equipped with stations for watchmen's portable clocks, having one station in the boiler-room, the rubbish-room, and machine-room, and one at each end of the corridors on each floor. The key boxes in the sub-basement were of iron, aluminum finished, with lift covers.

Those in the corridors were of the flush type, of bronze, finished to match the door hardware.

As soon as the construction work in the basement was finished, and the marble and tile workers had commenced work in the other parts of the building, the work of fitting up the Turkish bath in the basement was commenced. The swimming-pool was constructed of reinforced concrete, and lined with tile, with a combined scum gutter, life-rail, and overflow drain formed in the tile, and with a tile curb around the edges to prevent splashing. The scum gutter was provided with oblong bronze gratings, which were connected to two-inch wrought-iron pipes provided with running traps and discharging into the drainage system. The concrete shell for the swimming-pool was poured with the other concrete, and it was waterproofed with a membrane waterproofing on the inside to prevent the leakage of the water. The waterproofing was given a protecting coat of cement mortar one inch thick, which

was scratched to receive the floating coat. The floating coat was applied before the scratch coat had thoroughly set, and had an open-mesh metal lath bedded in it, to prevent the cracking of the tile. The tile was a ceramic mosaic tile, laid with a white field, and the depth marks, lines, etc., set in in black tile. The ceramic tile was used in preference to biscuit tile, as they are absolutely impervious, whereas biscuit tile are only impervious on the face, and any water getting behind the tile would do serious damage.

The pool was provided with built-in ladders of reinforced concrete, covered with tile, and set into recesses in the sides of the pool, so that there were no projections into the pool. The floors throughout the Turkish bath were of vitreous ceramic tile. The wainscot around the rooms, partitions around dressing-rooms, the partitions and tables in the shampoo-rooms, and the enclosures around the showers, were all of structural glass, the same as was used for the toilet-room partitions throughout the building.

The partitions around the Tepidarium and the Torridorium were of plate glass, double, with an air space between, set in white enamel steel framework. The heating of the Tepidarium and the Torridorium was done by means of concealed pipe-coils, taking steam from the high-pressure boiler at ten pounds' pressure, which gave a larger amount of heat than low-pressure steam would have given. Live steam was also furnished to the steam-room from this boiler. The baths were fitted with a hydriatic douche-room, with control table made up with structural glass sides and top, and fitted with thermostatic control mixing-valves and thermometers; nozzles and control-valves for supplying ice-water, hot and cold water, or steam, to the various fixtures and nozzles; needle and shower bath, with pipe-trench fitted with perforated brass cover; and a porcelain seat bath with wave spray, built into the wall.

An electric-light bathroom was included in the equipment, and it had two forty-six-

light electric cabinets, made up with white enamelled exterior and the sides and back of the interior lined with mirrors. These cabinets were fitted with thermometers and had separate switches to control the lights in each section. The shampoo-room had shampoo fixtures, fitted with thermostatic mixing-valves, thermometers, rubber hose with cloth insertion, spray nozzles, and nickel-plated copper tilting basins, with brackets and stops. The swimming-pool was supplied with filtered and sterilized water. All of the water, before entering the pool, was heated, using a water-heater of the same type as was used for heating the water for use in the building; it then went through a pair of vertical pressure filters, then through an ultra-violet-ray sterilizer, and then into the pool. This method of sterilization is particularly efficient, destroying all forms of bacteria in the water. It adds no taste and no odor to the water, and gives no irritation to the bathers.

The pool had a recirculating pump, which

drew the water from the pool, delivered it to the filters for clarification, and then to the sterilizer and back to the pool, so that the entire contents of the pool were recirculated, clarified, and sterilized once in every twelve hours. The sterilizer consisted of a cast-iron shell, made up in three sections, with proper baffle plates and a cylindrical clear quartz tube inserted in each section. Inside of these tubes, were placed mercury vapor arc-lamps, having a normal current consumption of about three and five-tenths amperes each. These lamps generated the ultra-violet rays, which were projected into the water as it passed around the quartz tubes, and all disease-producing bacteria were killed instantly. The sterilizer was equipped with a special switchboard, divided into four panels, one for the main control, and one for each of the three lamps.

The switchboard was equipped with switches, reactance coils, resistance controls for each lamp, telltale lamps, and pilot-lamps, as well as the necessary volt-

metres and ammetres. The sterilizer required 220 volts direct current, and as the current supplied by the local lighting company was alternating current, a three and one-half K. W. motor generating set was installed for the purpose of rectifying the current. A four-inch supply pipe was carried around the pool, with two-inch valve branches, with reducers connected to one-inch brass inlet pipes, two of which were located at the shallow end of the pool near the bottom, and four were located at the deep end, two at near the bottom, and two near the top. The pool had an eight-inch drain with bronze strainer and valved so that the water might be held for recirculating, or allowed to waste to the sewer when it was desired to renew the water.

The recirculating pump, which was of the horizontal, direct-connected, centrifugal type, with a capacity of 175 gallons per hour, with a fifty-foot head, was connected on the suction end with this drain, between the pool and the gate valve. The filters were of the vertical pressure type, with a

combined capacity of from 10,000 to 13,000 gallons per hour, with a cast-iron coagulant tank. The filtering material was silica quartz in three grades, placed in layers, the coarsest grade at the bottom and the finest at the top.

The barber-shop, which was to be operated in conjunction with the baths, was finished with tile floors and structural glass wainscoting, the same as described for the baths. It was equipped with vitreous china lavatories, fitted with self-closing faucets, and shampoo fixtures, fitted with thermostatic mixing-valves; vitreous china manicure-tables, with six-inch bowls, supplies and waste being located under the tables and operated by means of knee-action valves; and towel sterilizers which were operated by live steam taken from the high-pressure boiler, which supplied the steam for the baths. The work on the baths was not completed until all of the rest of the building was finished and occupied, as the unavoidable delays in getting specialties and installing them always make this

class of work progress very slowly. With the completion of this work our building was completed and our duties as superintendent ended.

AFTERWORD

Now, kind reader, as our tale is finished, we will say a word in parting. Some who have read these pages may have wondered where this building is, some might wish to visit it, so I will tell you: It never was; it is merely a creation of the writer's imagination, designed to illustrate the various materials and methods described in the various chapters, and the experiences and incidents were drawn from many buildings with which he has been associated in his fairly long and rather varied experience. The various conditions described may be applied to any modern building which the reader may have to do with, and if any lesson has been learned from the reading of them, the mission of these pages has been successful and the purpose for which they were written—that is, the helping of

the younger generation of the architectural profession to a better and fuller understanding of the problems of modern building construction—has been accomplished.

CHAPTER XII

A SHORT TALK ON BUILDING CONSTRUCTION

In the previous chapters I discussed some points on construction which I believed might be of some value to the young superintendent. In this one I will take up at random a few items which may be of assistance to the young men who are beginning their work as superintendents. For the most part these may be only trifles, but successful building is made up largely of trifles, but in itself is by no means a trifle. Most of the matter which will be discussed, a capable and conscientious foreman would do without being told, but as all foremen are not capable and conscientious, and some contractors are not honest, the architect's superintendent must at times take the initiative and see that certain things are done which would otherwise be neglected.

There are a great many "dos" and "don'ts" in building construction and some things which are right in warm weather are decidedly wrong in cold weather, and vice versa.

Another large factor to be taken into consideration in building operations where the builder and his foreman are perfectly honest and thoroughly well-intentioned, is carelessness, which very often brings about poor results in building, with absolutely no wrong intentions, and the vigilance of the superintendent will do much to offset that. When concrete is being mixed by machine, it is a good plan for the superintendent to see if the mixer is properly set so that the hopper does not spill the cement back of the machine, thereby losing a part of the most valuable ingredient of the concrete. When concrete is mixed by hand, and right here let me say that if it is in any way possible to avoid hand mixing, always do it, as no hand-mixed concrete is quite the equal of machine-mixed; be very careful to see that the water is not applied with

such force as to wash out the cement, leaving a very lean mixture, mostly sand and stone.

During very hot spells in the summer, when concrete is being placed, the sand and stone piles should be sheltered from the heat of the sun if possible, and the stone should be thoroughly drenched with water before using, to prevent too rapid setting of the cement, due to the heat. Fresh concrete must be kept dampened for several days after placing, to prevent cracking, by too rapid setting. When brick are being laid in cement mortar, in hot weather, be very careful to see that only a small quantity of mortar is mixed up at a time, only about enough to last about half an hour, as cement takes its initial set in about thirty minutes, and in hot weather a little quicker, and retempered mortar is of little or no value.

When circumstances render it necessary to place concrete in cold weather, and very often it must be done, great care must be taken to prevent freezing. Sand and

broken stone should be thoroughly dried and kept warm by embedding sheet steel cylinders in the bottom of the sand and stone piles and keeping wood-fires burning in them. Special precaution should be taken to avoid the use of materials covered with ice crystals or containing frost. The water should be heated before using, and a quantity of salt added to it. After concrete has been placed, it should be ordered to be protected from freezing, as much as is possible, packing over footings and around walls and piers with stable manure, tan bark or hay, which will keep out the frost very successfully in most cases.

Brick should always be wet before laying, except in freezing weather, or when there is a liability of the work freezing within a week after it is laid up. But brick should not be wet so much that they will run out of place when laid in mortar. In winter if the brick have been wet, or are coated with ice or snow, they should be thoroughly dried out and warmed before being laid, in the same manner as described

for sand and broken stone. Mortar for laying up brickwork in freezing weather should be mixed with warm water containing salt; also a good method is to mix in a small quantity of freshly slaked lime paste with the cement mortar; this will keep the mortar warm until the cement has obtained its initial set. Fire-brick, when used for lining boiler flues or furnaces, should never be wet before laying, as wetting swells the brick, and if they are exposed to heat before they are thoroughly dry, they are liable to be seriously injured by the straw in them. The fire-clay for laying up fire-brick should be mixed about as soft as a thick soup, and the brick should be dipped into the mortar, and then laid in place, and hammered down so as to get the thinnest possible joint.

In mill construction or wherever heavy wood girders have to be built into brickwork, or where the ends of roof trusses rest on the walls, brick must be laid away from the timber to give a circulation of air around it, to prevent dry rot. A very

good way to accomplish this is to have the carpenter tack a piece of seven-eighths board on either side of the timber, so fastened that it may be removed after the brickwork has been laid. Then after the brickwork is laid up and set, pull the boards out and a space nearly an inch wide will be left on either side of the timber. This costs next to nothing, as there is always an abundance of short pieces of scrap lumber on the job, and this may be used advantageously for this purpose.

Where steel beam girders are used to support brick walls, always have the girder shored up in the centre of the span, until the mortar is well set up, as the extra load caused by the wet masonry will cause deflection in the beams, but after the mortar has set the masonry arches itself and there is no longer any danger of deflection. Very often from one cause or another, especially in rebuilding after a fire, it is necessary to re-use old brick. Where this is done, and the walls are to be plastered directly on the brickwork, the superintendent should

be very careful to note if there are any smoked brick in the face of the wall. If such is the case he must order the smoked brick painted with R. I. W. or some of the various compounds of a similar nature, for if this is not done the smoked brick will stain through the plaster. If plastering is to be done with lime and hair, the superintendent should see that the lime has been thoroughly slaked and stacked until it has become thoroughly cooled before mixing with the hair, as mixing hot lime with hair burns up the hair, and its binding quality is entirely lost, and the plaster is liable to fall at any time.

Where roof trusses are exposed, the lower chords should be cambered; this will offset the bowed-down appearance of a perfectly level chord, and will also take up any deflection which may occur under loading. Cambering should be done by cutting the struts a little short, and drawing the chord up by means of the vertical rods. In mill or slow-burning construction, where heavy plank floors are used, always insist that all

flooring be kept a half inch away from all walls, because in case of the floors being drenched with water from any cause, the swelling of the plank might crack the walls. When plank floors are laid do not allow them to be spiked to the beams until the roof is on and made water-tight, as a heavy rain might swell the plank and cause a serious warping of the floors. Before allowing any interior trim to be put up or finished floors to be laid the superintendent should see that all plastering has thoroughly dried out, otherwise the kiln-dried lumber will absorb the moisture like a sponge, and warping and twisting will result, and the woodwork will be in an unfit condition for finishing.

When interior woodwork is to be varnished, before any work is done see that the building is thoroughly dried out and that it is not too cold; a temperature of from seventy to seventy-five degrees is the best for varnishing. If it is too hot when the varnish is applied it may blister. Dampness in the building after varnishing

may cause "blooming" or "going foggy." Before applying a second or third coat of varnish be sure that the under coats are thoroughly dry, otherwise the varnish may become brittle, crack or deaden. In case the varnish should "bloom" or "go foggy," the bloom may be removed by washing very lightly with kerosene, and rubbing it gently with a soft woollen cloth. Varnish should never be thinned except when it has become heavy and will not flow, and then it should only be done with pure spirits of turpentine. Never permit the use of oil, Japan, or liquid dryers. The varnish and turpentine should be as near the same temperature as possible, before mixing, and after being mixed should be allowed to stand for a while, to insure a perfect amalgamation.

These are just a few of the many points which are continually occurring in building operations, which the superintendent must decide.

There is one little piece of advice which I would give to the young men starting

out as superintendents, and that is, never be too proud to take advice and information from the mechanics and workmen on the buildings. They may not have a great many ideas, but some of the ideas which they have are very good, and the writer has profited not a little from what he has been told by them.

PART II

The Writing of Specifications

CHAPTER I

CARE AND SPECIAL KNOWLEDGE ESSENTIAL. THE IMPORTANCE OF DEFINITENESS. THERE SHOULD BE NO ROOM FOR DOUBT

In the present seeking after efficiency and system in all lines of architectural effort, the architect's specification must needs have its inning.

Working drawings have been improved wonderfully of late years, but specifications, unfortunately, have not kept pace with the steady march of improvement.

Many of our leading architects, whose drawings are above reproach, still continue to send out specifications that are of little practical value to the contractors; in fact, in some cases they are almost useless.

An accurate, carefully written specification will do much to overcome many of the troubles which architects have with their buildings, reduce the number of extras,

prevent misunderstandings, and, above all, in contracts which are let by competitive bidding, get lower bids and oftentimes save expensive revision of drawings when bids run too high and something has to be done to reduce the cost.

Although in these times draughtsmen are both numerous and capable, good specification writers are comparatively few in number, and a great many of our most able office assistants know very little about that quite essential part of an architect's work, the writing of specifications, and for the most part show little or no inclination to learn.

The reasons for this condition are obvious. In the smaller offices the architect frequently writes the specifications himself, therefore the assistants have no part in it. The opportunity to learn much about the subject is limited, as our architectural schools are obliged to crowd so many essentials into a short four years' course that the subject of specifications can only be briefly touched upon, and for those who

may wish to take up the study of the subject after finishing school the number of books on the subject is few, and the really valuable books are only a very small portion of that few.

It is not the intention of the writer in this short chapter to tell all about specification writing, mostly because he doesn't know it, and also because the subject is altogether too large a one to be treated to a finality in one chapter; but for the benefit of those younger members of the profession who may wish to learn something of the subject, I will detail some of the points which I have found valuable in writing specifications, and some errors which I have found in my own and in other men's specifications which may be avoided.

The two first and great essentials of a really good specification are completeness and brevity; every point to be covered, and no unnecessary verbiage to confuse the contractors and hide the real meaning of the various clauses of the specification.

A specification should be so written that

in case of dispute it could be taken into court and stand the test of litigation successfully.

Right here let me impress upon the reader the value of the liberal use of the word "all." Wherever it is possible specify "all." As in excavation, say: "The contractor shall do all excavating required to complete the work, etc.," and there is no room for quibbling over how much is to be done or included in the contract.

In writing a specification, one of the first essentials in obtaining the best results for all parties concerned—the owner, the architect, and the contractor—is to arrange the work of all trades as nearly as is possible in the order in which the building is constructed; also to have all of the work which is to be done by any one contractor arranged in direct sequence, as it is not fair to assume that a subcontractor will read all through a long specification to find any part of his work which may have been written into some other part of the specification.

In writing the specification for any one trade, always specify the materials and workmanship first, that the contractor may know what he has to furnish; then specify what parts of the building it is to be used in, and he can tell how much he has to furnish.

Careful checking after writing is very essential, as many contractors are only too willing to take a contract, knowing full well that there are important items omitted in the specifications, and then after signing the contract to make extortionate demands for extras.

The first part of all specifications being the general conditions, it is well to consider them first in starting to write a specification. The American Institute of Architects publishes a very thorough and complete set of general conditions which, in the opinion of the writer, should be used whenever possible, to promote a uniformity in specifications and a greater harmony between the architectural profession and the building trades.

That a certain amount of standardization of specifications is desirable cannot be denied and all movements toward that end are welcome, but, on the other hand, over-standardization is always questionable, and most all specifications which have been made up of stock clauses and by means of card indices have been failures. In the specifying of materials one cannot be too explicit as to quality, grade, etc. With lumber and timber, always give grading as called for in the grading rules of the lumber and timber associations.

In all cases where a standard specification has been adopted by the American Society for the Testing of Materials, specify that material shall be according to the society's specification.

One of the most vexing questions in the specifying of materials is that phrase "or equal to," which causes more worry and trouble than anything else in the whole range of specification writing.

If any material or appliance is so high in quality as to be accepted as a standard

there is in all probability nothing on the market which is equal to it, and in nearly every case the contractor's idea of "equal to" is something much cheaper. So if a certain article is wanted and it is believed to be the best of its kind, specify it outright, because you believe that it has no equal.

With most materials where special makes or patterns are not particularly desired, it is best to follow the method of the United States Government and call for certain requirements as to weights, method of manufacture, and quality, establishing a standard of what you require and allowing any materials meeting those requirements to be used.

In private practice it is not necessary to follow that method, which, however, with the government is mandatory, as the law does not allow materials or appliances to be used on government buildings to be specified under make or pattern.

In specifying materials for any proposed work an important factor to be considered,

one which many of us are prone to forget, is the satisfying of the client, which is really quite a large factor, and should always be considered, and if any particular material or appliance which is not absolutely inferior strikes his fancy or appeals to his taste it is advisable to specify it, even though it is not just what you would recommend yourself, as, after all, he is the person to be pleased. In starting out to write specifications it must be remembered that the specification writer should have a very thorough knowledge of all materials and methods of construction, both in the field and in the shop, without which it is very hard to write knowingly and clearly on the subject, so therefore the candidate for specification writing should have some experience superintending construction before attempting to write specifications.

CHAPTER II

WRITING SPECIFICATIONS FOR A SMALL HOUSE

THE specifications for small houses have in the past, as a general thing, played a very small part in the affairs of the architect. In most cases the small house has been built by aspiring young architects, or by near-architects who have graduated from the carpenter's trade or just took to architecture naturally; consequently, the specifications have been far from complete. All of this was very well when prices were normal and a house could be built for something like a reasonable amount of money, but in these days of high prices for both material and labor, and with the entire country facing a shortage of housing, the question of small-house building bulks very large.

In open competition nothing helps the bidder more than careful and complete

specifications, couched in simple language, and free from unnecessary verbiage and needless repetition. Without proper specifications an honest builder will bid high to cover contingencies, and dishonest and tricky ones will bid low and then try to make their profit on the overcharging of extras and the using of inferior materials where no definite mention has been made in the specifications. It can be said the surest way to get what you specify is to be sure you have specified it. Taking, as an example, the very pleasing little house by Mr. Hertz illustrated in the June number of *Architecture*, we will discuss the specifications for such a house, to be built in various localities, in the most satisfactory and economical manner.

After specifying the excavation, grading, and refilling, the first item to consider will be the footings, which in all cases, except where it is nearly or quite impossible to obtain broken stone, concrete should be specified. Concrete should be mixed in the proportions of one part cement, three parts

sand, and six parts broken stone. The cement should be an approved brand of Portland cement; the sand should be clean, sharp, and well graded, and free from loam, clay, vegetable matter, or salt; broken stone should be good, hard stone, free from dirt or crusher dust, and it may grade up to two and one-half inches in its greatest dimension. If easier to obtain, a clean, coarse gravel or crushed blast-furnace slag may be specified. Concrete may be mixed either by machine or by hand, but in either case the resulting mixture should have the stone thoroughly incorporated in the mixture, and each batch should be of uniform color and consistency. Foundation walls may be specified to be of concrete, if other materials are not cheaper or more easily obtained.

Forms for concrete should be of dressed lumber, well braced and properly wired together to prevent spreading. If the soil is damp, and there is any liability of water seeping into the basement, the concrete should be waterproofed. This can be done,

with very little added cost, by specifying that all concrete below grade shall have fifteen pounds of hydrated lime added to each bag of cement used. This will effectually close all of the pores in the concrete. The cellar floor should be of concrete, the same as specified for the walls and footing, finished with a cement finish composed of one part of cement and two parts clean, sharp sand, floated on while the concrete is still wet and trowelled smooth. Finish which is put on after the concrete is set seldom bonds with the concrete, and is liable to crack and shell off. If it should happen that split ledge stone is plentiful and easily obtained in the locality where the house is to be built, rubble-stone walls may be specified, and the chimneys up to the level of the first floor may also be laid up in rubble-stone masonry. The stone should be specified to be large-size stone, laid to the lines on both sides. All stone should be laid on its natural bed, should be well bedded, and all voids filled solid with spalls and mortar.

The walls should have one header extending through the wall every two feet in height, and every three feet in length, and properly staggered. Headers should be good flat stone, not less than twelve inches wide and eight inches thick. No stone should be used which does not bond into the wall at least six inches, and at least one-half of the stones should be two-thirds the width of the wall. The foundation walls should be laid up in cement mortar, composed of one part Portland cement and three parts clean, sharp sand. All brick should be specified to be good, hard, well-burned, local brick, free from swollen or refuse brick, to be laid up with level and completely flushed joints. All brick which are not laid in freezing weather should be thoroughly wet. Mortar for laying up of brickwork above the foundations should be specified to be lime and cement mortar, composed of one part cement, one part slaked lime or dry hydrated lime, and six parts clean, sharp sand.

All fireplaces should be specified to have trimmer arches, which should be set low enough to allow for setting the hearths. All chimney flues should be lined from the throats of the fireplaces to the top of the chimney with terra-cotta flue lining. It is an excellent practice to specify that four inches of brick should be laid up between the first-floor joists the full height of the joist. This will make the house warmer in winter, retard the progress of fire, and prevent rats and mice getting into the walls.

The kind of timber specified will depend entirely on the locality in which the house is to be built; in some sections spruce is used, in others white pine is used, and in the South yellow pine is used almost universally. The grade of timber should be specified. If white pine, No. 2 timber and No. 2 dimension should be used; if yellow pine is used, square-edged and sound should be specified. As a word of warning, let me repeat what almost every writer on specifications has already said: "Don't

specify structural timber to be free from knots and all other defects," as the grading rules for timber allow a certain percentage of knots and other defects, so that such conditions cannot be enforced on the contractors, and have a tendency to cause your specifications to be held up to ridicule by them.

All headers and trimmers should be specified to be doubled, and all headers over five feet long should be specified to be hung in wrought-iron stirrups, or some form of patent beam-hangers. All joists which come under partitions should be specified to be doubled. The sheathing and under flooring should be specified to be No. 3 D. and M. common boards, either white pine or yellow pine, according to the local market. Although this stock is defective, and does not look very well, it is sufficiently good for sheathing and under floors where the knots, sap stains, and other defects will be covered. The sheathing and under flooring should be specified to be laid diagonally, as it tends to brace the frame.

The walls should be specified to be covered with a good grade of sheathing paper, to be lapped three inches and nailed to the sheathing boards with large-headed nails. Wherever the appropriation will allow it, specify cross furring on all ceilings, as it gives a much more level ceiling and a better surface for lathing. The furring strips should be of undressed lumber, ⅞ inch by 2 inches, spaced 16 inches on centres.

All of the lumber for the exterior finish should be specified to be either white pine "C" select finishing, or yellow pine "B" and better. The weather-boarding should be of seven-eighths-inch stock, nine and one-half inches wide, surfaced one side and both edges, and laid eight inches to the weather. The porch columns should be specified to be a lock-joint column, and they should be flashed on the tops of the caps with sheet lead.

Wherever the use of wood shingles is not prohibited by the local building code, they may be specified, and they make an excellent roof. The greatest danger from wood

shingles is generally found in the advertisements for non-combustible roofing materials. Either Western red-cedar or cypress shingles may be specified—whichever is the more easily obtained in the locality in which the house is to be built, although in most cases the cedar shingles will be the cheaper. "Extra clear" should be specified except where cost must be kept down; then, "Star A Star" may be specified. They should be laid four and one-half inches to the weather, if sixteen-inch shingles are used, and five and one-half inches to the weather if eighteen-inch shingles are used. Each shingle should be nailed with two 3 d. zinc-coated nails. Specify that all valleys and hips shall be laid close, using wide shingles, cutting them to the proper shape, and working 9-inch by 14-inch pieces of tin into each course of shingles.

The window-frames should be specified to have two-inch rabbeted sills, one-and-one-eighth-inch pulley-stiles, one-half-inch parting beads, and one-half-inch stop-beads, the remainder of the stock to be

seven-eighths inch thick. The pulley-stiles in all cases should be specified to be of yellow pine, the balance of the frame to be of the same kind and grade of lumber as is specified for the exterior finish. The frames for double-hung windows should have three-sixteenths-inch pendulums hung from the yokes by means of galvanized annealed wires. Casement windows should have one-and-one-half-inch rabbeted plank frames. The sash should be made up of factory lumber, white pine, yellow pine, or cypress. They should be mortised and tenoned, and pinned. The casement sash should have moulded astragals and drip moulds.

The exterior door-frames should be one and three-quarters inches thick, rabbeted, with two-inch sills and seven-eighths-inch outside casings. The sills should be specified to be of straight sawn red oak. The interior door-frames should be seven-eighths inch thick, with five-eighths-inch adjustable stops, ploughed in, and they should be properly blocked up for hinges

and lock strikes. If hardwood doors are to be used, they should be specified to be veneered. The veneering should be done on cores of white pine or wormy chestnut, one inch wide by the necessary thickness, glued together. The veneers should be one-quarter inch thick, and the end veneers should be one-half inch thick. Always specify that the stiles and rails of doors should be ploughed, and have a pine cleat glued in, to which the mouldings shall be nailed, so that the panels will be loose.

For interior doors, several very good types of veneered stock doors are on the market, which may be specified.

The interior finish may be specified to be either white-pine "C" select finishing, "B" yellow-pine finishing, or F. A. S. yellow poplar, all of which take paint or enamel very well.

The stairs should be specified to have heavy plank stringers, and main stairs should have treads one and one-eighth inches thick, and risers seven-eighths inch thick, tongued and grooved together, treads into

risers and risers into treads. The size of the newel-posts and angle-posts should be specified, whether they are to be turned or built up. The size of the rails should be specified, and if they are to have ramps and easements, it should be so specified. The size of the balusters should be specified, how many to the tread and whether they are to be plain or turned, also specify that the balusters on landings shall be spaced the same as those on the treads. The cellar stairs should be specified to have plank strings, rough treads and risers, and plain seven-eighths-inch hand-rail dressed.

If oak floors are to be specified for the principal rooms, red oak "select" may be used, as it will wear as well, and after staining and finishing, look nearly as well as white oak "clear," and will cost much less. For kitchen and pantry floors, if they are not to be covered with linoleum, factory-grade maple may be specified. This makes a particularly hard, durable floor, and with a little culling out of the particularly bad pieces it can be laid so as to

look very well, especially if it is to be stained in the finishing, so as to obtain even color. If the floors are to be covered with linoleum, specify either "D" flat flooring yellow pine or "D" white pine flooring, according to the price in the local market. For bedrooms, a "C" flat flooring yellow pine makes a very good floor. Where strict economy is necessary, all flooring may be specified to be of yellow pine. All flooring should be specified to be standard, matched flooring, to be blind-nailed with 8 d. nails, and all joints to be well broken.

Tile floors should be specified to be laid on concrete foundations three inches thick, which are to be laid on seven-eighths-inch rough-board platforms set between the floor-joists, and resting on seven-eighths-inch cleats nailed to the joists. The concrete to be the same as specified for the footings, etc. The tile should be set in a levelling bed of cement mortar one-half inch thick, in which has been bedded a painted or galvanized open-mesh wire netting. The

joints in the tile should be specified to be grouted with cement mortar, mixed to the consistency of thick cream, and all of the surplus cement should be cleaned off before it has set. The joints in quarry tile should be specified to be one-half inch thick and slightly concave.

If a tile wainscot is specified for the bathroom the walls behind the tiling should be specified to be plastered with cement mortar on metal lath. The lath should be well lapped and stapled to the studding. The mortar should be mixed in the proportions of one part Portland cement and two parts clean washed sand, to be well scratched in a horizontal direction to receive the setting bed. The tile may be specified to be either floated on, or buttered. Specify that the tile shall have the joints washed out and be neatly filled with thinly mixed white Portland cement, all surplus cement being cleaned off before it has hardened.

If hung gutters are to be used, they should be specified to be No. 26-gauge gal-

vanized iron, with slip joints, and be hung in adjustable galvanized hangers. If box gutters are to be used, they should be specified to be lined with I. C. 40 pound coating tin, with flat seams, the tin to be painted on the under side with red-lead or iron oxide before laying. The leaders should be specified to be No. 26-gauge galvanized iron, and to be provided with cast-iron shoes at the ground to connect with the drainage system.

The canvas roofs over porches and sun-parlors should be specified to be of twelve-ounce cotton duck, tacked with seventeen-ounce tinned carpet tacks, the edges of the duck being lapped one inch. After the duck has been laid it should be thoroughly wet, and then painted with pure white-lead and boiled linseed-oil before it has dried. Give it two extra coats of white-lead and oil, allowing sufficient time between the coats for drying.

In specifying the painting, pure white-lead and linseed-oil, with the addition of 20 per cent of French zinc white should be

called for. Now that the war is over, French zinc white is obtainable, and its use is recommended, as it greatly increases the oil-carrying capacity of the paint, and thereby prevents flatting and chalking. In writing the specifications for enamel work, it is well to follow the manufacturers' specifications absolutely. In kitchens and pantries a very good low-priced job which stands well can be obtained by specifying one of the several mill whites which are on the market. These can be put on in three coats—finish, gloss, or egg-shell. They will stand any ordinary usage, are not affected by steam from cooking, wash easily, and do not turn yellow. The floors may be specified to be varnished or waxed, varnish being the cheaper. In either case, the floor should be specified to be perfectly clean and dry before finishing. The floor should first be stained with an acid stain, then filled with a paste filler, lightly sanding each coat. Never specify shellac or liquid fillers as first coats on floors, as they will not stand the wear and tear. Then specify

either two coats of reliable make of floor varnish or two coats of prepared floor wax. The second coat of varnish may be rubbed with pumice-stone and oil, or left in the gloss. The floor wax should be applied with a rag, and each coat polished with a weighted brush, rubbing it with the grain.

Before starting to write the specifications for the plumbing it would be well to become familiar with the local sanitary code, if one exists, and avoid specifying anything which is contrary to the code, which will help to prevent extras after the contract is let.

The materials and sizes of house sewers, house drains, fresh-air inlet (if required by the local ordinances), and soil stacks should be specified. The house sewer should be of vitrified tile-pipe, and six inches in diameter will be large enough for a moderate-size house. The house drains and soil stacks should be of cast iron four inches in diameter. One of the leading authorities on plumbing advocates three-inch soil pipes, but it would appear to the writer

that he is taking a chance, so it will be well not to specify less than four-inch pipe, except for waste from isolated sinks or lavatories, which may be of cast iron two inches in diameter. Short branch wastes from lavatories or sinks may be of galvanized wrought iron or lead, one and one-half inches in diameter. Unless the sanitary code calls for back-venting, do not specify it, but call for non-siphon traps of some type which have been thoroughly tested and been proven to be efficient. The efficiency of back-venting is questionable, and it adds materially to the cost of the building.

The young architect is very liable to leave the size of the supply pipes and branches entirely to the plumber, which is a dangerous practice, as he is liable to have rather optimistic ideas as to how much water can run through a small-size pipe, especially if he has not figured in a large profit on the job. Therefore, the sizes of pipe should be specified. The main supply from the street in a house of this

size, having two bathrooms, a kitchen sink, laundry trays, and servants' water-closet, should be one and one-quarter inches in diameter unless low street pressure or excessive distance from the street make a larger size necessary. Branch to laundry and servants' water-closet should be three-quarters inch in diameter. Branch to hose connection should be three-quarters inch in diameter, and should have a stop-cock so placed as to drain the line. Boiler supply should be one-half inch in diameter.

As a gas-heater will be required, specify a three-quarters-inch branch to the heater. The main riser to the third floor should be one inch in diameter, taking off a one-half-inch branch to the kitchen sink; the branch supplies should be specified to be one-half-inch diameter to the shower-bath and the bathtubs, and three-eighths-inch diameter to the water-closet tanks and lavatories. The gas-heater should be specified to be one of the several instantaneous heaters which are on the market, and should be specified to have a galvanized-

steel storage boiler, connected with the house heater, so that in the winter months, when the heater is being run, gas will be used only to boost the system in case hot water is drawn more rapidly than it is being heated.

In the selection of the plumbing fixtures much must be left to the discretion of the specification writer, as the question of cost and the desires of the client are largely to be considered. Where the appropriation is small, specify enamel iron bathtubs, lavatories, sinks, and wash trays. Where more money is available, specify vitreous china lavatories and porcelain tub in the family bath. In any case, specify the make and pattern desired, and insist upon getting them. The gas piping should be specified to be standard galvanized mild steel pipe, with galvanized, malleable iron beaded fittings.

All pipe should be run level where possible, and when necessary to be pitched it should grade toward the riser and should be without traps. Specify that the pipe

should be put together with red-lead or litharge, and that gas-fitters' cement will only be allowed at the outlet caps. System should be specified to be tested for one hour with an air-pressure equal to fifteen inches of mercury, and that the mercury must not drop more than one-quarter inch during the test.

Both as a point of economy on installation and on account of many owners preferring it, hot-air heating may be specified, in which case be sure to specify that wherever the pipes run in the partitions the studs should be covered with tin, and that the lathing over the pipes should be done with metal lath. All pipes which run in the partitions should be specified to be made double, with an air space between the inner and outer pipes. It is also well to specify that all the pipes in the cellar be made double, as it insulates them, making it easier to heat the rooms, and saves fuel.

The specifications for steam-heating and electric-wiring having been thoroughly dis-

cussed in *Architecture* of April, 1919, nothing will be said of them at this time. As far as is possible in the limited space in a single chapter, the writer has tried to cover the most important items in the specifications of a moderate-size house of moderate cost, but in all cases the specifications will vary according to the design and the desires of the owner, but the general principles will always be the same.

CHAPTER III

DANGER-SIGNALS FOR SPECIFICATION WRITERS

In a preceding chapter I gave a general outline of the leading requirements in specification writing. In this chapter I will detail some items which should be embodied in specifications and some which should be avoided, and the general reasons therefor. As I stated in the previous chapter, what I write is not intended so much for the experienced specification writer as for the younger members of the profession, and although some things may appear very trivial to the older readers, a great many of them were learned through unpleasant personal experiences. In writing a specification for any particular building, the first points to be considered are the local conditions, the materials which can be obtained, the local labor conditions, and the local building

code, if the latter exists, for to specify any materials which are unobtainable, or which are prohibited by the code, is liable to raise questions on the part of the contractors and cause considerable trouble for the superintendent on the work.

This, naturally, only applies to buildings which are to be built at a distance from the office, as it is understood that the specification writer, no matter how inexperienced he may be, is reasonably well acquainted with the conditions which prevail in the home town. In calling the reader's attention to the various points in the specifications which may save trouble and worry for the architect, the owner, and all concerned, the writer will take up various parts of the work in much the order in which the specifications would be written.

In concrete work, where any large amount of concrete walls are to be used, always be sure to specify that a sufficient number of expansion joints shall be made, as otherwise serious cracking of the concrete may occur.

Also, in specifying concrete, attention should be paid to specifying the amount of water which is to be used in mixing the concrete, as an excessive amount of water decreases the strength of the concrete; about six gallons of water to a bag of cement being the average amount which should be used. Whenever concrete or cement stucco are to be painted, never specify a paint having linseed-oil as a vehicle, as the alkali in the cement will saponify the oil and the larger part of the paint will be washed off by the first heavy rainfall. The safest method is to specify some reliable and well-tried concrete coating or primer, of which there are many on the market.

In specifying cut stonework, care should be taken to specify the thickness of all ashlar, four and eight inches for alternate courses being ample and sufficient in ordinary work, but eight and twelve inches should be specified for high-class work. All joints should be specified to be cut back one and one-half inches from the face of

the stone. All limestone and marble should be specified to be laid up in mortar composed of an approved brand of non-staining cement, and the backing up brickwork coming in contact with the stone should also be laid up in non-staining cement mortar. All top joints in copings, cornices, pediments, etc., should be specified to be caulked with oakum and pitched or pointed with some approved plastic compound. All anchors, dowels, clamps, and other ironwork used in the securing of stonework and terra-cotta should be specified to be galvanized, as plain iron is liable to rust and stain the stone or terra-cotta. In very high-class work, where cost does not have to be considered, use copper clamps and dowels in all stonework.

Wherever structural steel is to be embedded in concrete or brick masonry, do not specify painting the field coat with any paint having linseed-oil as a vehicle, for the same reason as previously stated relative to painting concrete. Specify a paint having a bituminous base, as it is

not affected by alkalies and also has excellent qualities as a damp resistant. When specifying pipe railings, never specify galvanized-iron pipe or fittings, specify black iron; as galvanizing fills the pores, and paint will not adhere as well to the smooth surface and is liable to peel off.

Most specifications for architectural bronze work are drawn very loosely, often only saying "all bronze work shall be the best statuary bronze," which means very little. To obtain the best results the alloy should always be specified. One of the leading bronze foundries recommends an alloy of not more than 7 per cent tin, not more than 3½ per cent lead, the balance to be pure copper. Also, the finish should always be specified. For high-class work it should be all hand-chased. For cheaper work, statuary finish, which merely consists of removing the fire skin from the castings and filing the bright parts, may be specified. Furthermore, in specifying bronze work, it should be stated that where more than five duplications are wanted,

the patterns must be highly chased metal patterns, otherwise the castings will not be clean and sharp.

Wherever wall tile are specified to be set on plastered partitions, the plastering should be done with a one to two Portland cement mortar, deeply scratched to give bond for the mortar in which the tile is set. Always specify metal lath on all stud partitions behind tiling. Interior marble work should always be specified to be set in plaster of Paris, and all clamps and dowels should be specified to be of copper or brass.

All fragile marbles, like Pavanozza or Sienna, should be specified to be backed up with a hard, cheap marble, to prevent fracture.

All floor sleepers which are to be bedded in cinder fill, and all blocking and other timber which is to be bedded in concrete, should be specified to be treated with a brush coat of an approved creosote wood preservative.

Whenever double flooring is to be laid

in a fireproof building, on top of cinder fill, never specify tongued and grooved stock for the under flooring; always specify square-edged stock, laid with open joints, for if tongued and grooved stock is used, and the joints are driven up tight, there is no chance for the moisture to escape, consequently a swelling and buckling of the under floor, causing damage to the finished floor.

When copper roofing is to be specified, either flat seam or standing seam, never specify heavier than sixteen-ounce copper, as the expansion and contraction of heavier copper has such a pulling force that it will tear loose. Wherever copper is to be soldered, always specify that the edges of all sheets shall be tinned, as tinning makes a much better holding surface for the solder. In all copper work such as roofs, gutters, leaders, or skylights, always specify that the contractor shall make proper allowance for expansion and contraction of the metal.

In specifying roofing, either shingle, slate, or tile, always call for all nails to be either

galvanized or copper-coated, and in all high-class work specify composition or yellow metal nails for slate or tile, as plain iron nails rust out very rapidly and cause shingles, slate, or tile to loosen, thereby causing leaks in the roof.

If frame buildings are to be built at the seashore, always specify that all nails, except those to be used on interior trim, shall be galvanized, as the salt air corrodes plain iron nails and materially shortens the life of the building by allowing water to get to the sheathing and frame and rotting them out.

Wherever wood louvers are used for ventilating the roof space in a building, always specify a moderately fine copper mesh to be nailed directly behind them, as it will effectually prevent the snow from blowing in and damaging the ceilings, and also will keep out birds and insects. Always in all good work, specify that the back of all hardwood trim and wainscoting shall be painted one coat of red-lead and boiled linseed-oil, to keep out dampness

and to prevent warping and swelling of the wood. All sash should be specified to be glazed at the building, for if they are glazed at the mill and then transported to the building, the putty still being soft, the glass may loosen, and the loose glass will rattle in the wind, making it unpleasant for the occupants of the building, and water will get between the glass and the putty and cause the sash to rot.

All metal sash should be specified to be glazed with a self-hardening putty, composed of whiting, white-lead, litharge, and raw linseed-oil, proportioned about 12 to 14 per cent oil, 5 per cent litharge, 78 per cent whiting, and the balance white-lead, as ordinary putty will not harden on metal sash. All galvanized sheet-metal work should be specified to be thoroughly cleaned with vinegar or acetic acid to remove all grease before painting, which helps to prevent peeling which is so common with galvanized sheet-metal work; also, specify to paint the first coat with red-lead, into which has been mixed a wax solution, which

is made as follows: melt a cup of pure beeswax, and when it has reached a fluid consistency, pour it into a gallon of raw linseed-oil, heated to 200 degrees Fahrenheit. For use add one quart of the wax solution to every one hundred pounds of mixed red-lead paint.

In the writing of plumbing specifications, always, where any fair-sized supply pipe is to be used, and if the local water-supply is taken from a pond, lake, or river, call for a fish-trap to be placed on the supply, on the street side of the metre, to prevent fish, weeds, and other foreign matter from entering the metre. All wrought supply and waste pipe should be specified to be genuine, puddled wrought iron, for although the cost is greater than steel pipe, the very rapid corrosion of steel pipe makes its use a very doubtful economy. Where cost has to be considered, and the sanitary code does not forbid its use, it is allowable to specify standard cast-iron pipe; but wherever pipe is to go under ground, always specify extra heavy. Never specify stand-

ard pipe in a building to be built near the seashore, as the salt air corrodes iron very rapidly, and only extra heavy pipe should be specified. If a building is over twelve stories in height, an expansion joint should be called for on the hot-water rising lines.

If it is in any case absolutely necessary to run any wrought-iron pipe in cinder fill, the pipe should always be specified to be coated with neat cement, or some approved preservative compound, for if not protected the pipe is very liable to corrosion, either from the chemical action of the sulphur in the cinders, or to electrolytic action of the carbon in contact with the damp iron. Always specify that the plumber shall install a heavy sheet-lead pan under the floor-slabs of all shower-baths, the sides of pan to be carried up at least four inches around all sides and made water-tight; unless this is done there is always liable to be leakage at the joints between the floor-slab and sides of the shower-stall, with the consequent damage to the ceilings below.

In fireproof buildings the floor-slabs

under all toilet and bath rooms should be specified to be waterproofed, and all pipes which run through the floor-slabs should be specified to have waterproof collars, to be properly connected to the waterproofing over the slabs. This should be done to protect the ceilings below in case of leaks or overflows in the plumbing system.

In writing specifications for gas-piping or electric-wiring in new fireproof buildings, always call for all pipe or conduit to be laid top of floor beams, instead of beneath them, and all cutting to accommodate pipe or conduit shall be done not more than three feet from the ends of the beams, and in no case shall it be more than two inches deep, for in many sections of the country where there are no provisions in the building codes prohibiting it, gas-fitters and electricians will cut out on the lower edge of the beams to accommodate pipe or conduit, which will materially weaken the beam, as the lower fibres of all floor beams are in tension, also the pipe or conduit must

be supported by straps to prevent sagging, whereas if laid top of beams it is thoroughly supported by the beams.

One thing which I would call the reader's attention to particularly is the emphasizing in the specifications that wherever patent compounds such as ready-mixed paints, enamels, waterproofings, floor hardeners, etc., are specified, they must always be applied strictly in accordance with the directions of the manufacturers, and that no adulteration of any sort or kind shall be permitted.

When specifying patent preparations of any of the above-mentioned kinds, do not make a practice of specifying new and practically untried materials, for ambitious chemists and manufacturers are bringing out new compounds steadily, giving them a few not overexhaustive laboratory tests and then trying, by means of alluring advertisements and a line of very pretty samples, to persuade the architects to specify the materials, that is, in other

words, "to try it on the dog," and the thing for the specification writer to beware of is to avoid being placed in the position of the dog.

CHAPTER IV

WORKABLE DRAWINGS

THERE are working drawings and workable drawings, a slight distinction but a big difference, to which any builder or builder's superintendent will readily testify, and some drawings fail in their purpose by having too much on them, while others fail by having too little.

The draughtsman should not try to write the entire specification on the drawings, and yet he should put on enough notes to properly explain them. Another aid to the builder is marginal details to a larger scale on the plans, elevations, and sections, but in putting marginal details on the drawings the draughtsman should always remember to put the details on the sheet where that particular piece of construction occurs: not like a draughtsman of the

writer's acquaintance who put a detail of basement construction on the roof plan—as he naïvely put it—"because there was room on that sheet and the builder would find it anyway." How many things are left for the builder to find, and how many, as a result, are not found until afterward, and the builder pays the bill or the owner pays an extra.

Right here let me repeat what was said to me by one of the older architects, some years ago: "Always work under the assumption that every mechanic is a fool." Therefore, if drawings are made so they are fool-proof, or nearly so, they will not offend the sensibilities of the great number of very intelligent mechanics who are still with us, and will also prevent the less intelligent ones from making very natural mistakes, which are always liable to happen.

After the drawings are completed, and everything is properly indicated, the most important item on the drawings is the figures, and there is where many young

draughtsmen fail. All four sides of a plan should be figured, even though the building be perfectly symmetrical and two of the sides be duplicates, as the writer has known of a case where the builder's superintendent laid out one side of a pilastered building by the figures, and the other side by scale measurements taken with a two-foot rule, and as the drawings were not accurately drawn, the result was startling to say the least.

All lines of figures should be continuous from end to end of the building, so that the builder may prove up his work and, if he finds any discrepancies, can report them to the architect for correction. Care should always be taken in putting of figures on the plans not to have them come on top of plumbing fixtures, light outlets, etc., as they are liable not to be seen, and if seen, may be very hard to read, as the blue-prints are very often not as legible as the tracings from which they are made. Also where wall thicknesses are figured, do not hatch over the figures; leave good-

sized open spaces to call attention to the figures. Figures should be from rough to rough, that is, from brick wall to brick wall, or from stud to stud, as the work will be laid out and the rough construction set, and the finish put on that, and if the rough work is correctly set, the finish must naturally be correct.

All columns, beams, girders, and trusses should always be figured to centres, whereas it is a better practice in figuring brick and stone buildings to figure openings, pilasters, etc., to joint or to arris. Don't figure to the axes of rooms, etc. It is better to figure from wall to wall, as in laying out the work the builder will have to double the figures, as he will not have the axis fixed, as an axis, like the equator, is an imaginary line; it is very necessary, in fact, indispensable in designing, but it can be wisely disregarded in the figuring, except in very special cases where it is the only possible station point from which to work. Always, in figuring, avoid the use of fractions which are not multiples of four, such as

thirds, sixths, and seventeenths, as the mechanics use the divisions on the two-foot rule.

If there are three panels on the front of a building, it is a very simple matter to figure the centre one a quarter of an inch wider than the two side ones, and no human being, no matter how close he might look, would ever be able to tell the difference. There is one exception to this rule though, and that is, in figuring the height of the risers in iron staircases; which should always be figured in inches and decimals of an inch, as it is the custom in stair-shop practice to use a decimal rule in laying out risers. On the other hand, the treads should always be figured in inches and eighths. In figuring the risers in wooden stairs, divide the height from floor to floor by the number of risers, carrying the decimal out at least three places, and then by referring to the table on page 408 of the Cambria Steel Company's handbook, convert the decimals to the nearest fraction in sixteenths of an inch. Any little dis-

crepancy will be taken up by the stair builder on the top and bottom risers.

The young draughtsman will do well, for many reasons, to procure a steel handbook and become more or less familiar with its contents, as there are a great many helps in them which are not engineering matter, such as the sizes of structural shapes, the sizes of bolts and nuts, conversion tables, and much other matter which is very often needed by the architectural draughtsman in full-size detailing, figuring of plans, and other practical parts of his work.

The first and most important thing in drawing an elevation, and something which the writer has found it rather difficult to get the young man fresh from college to do, is to show the floor lines. As a presentation drawing, an elevation looks very well without floor lines, but on working drawings they are vitally necessary. Elevations and sections should be figured from finished floor to finished floor, and openings should be figured from finished floor to

sill, and from sill to head. In figuring the heights in a brick building, they should always be figured to work out in brick courses, so that all courses will work out even. The Hydraulic Press Brick Companies of St. Louis publish a book of figured heights for the various thicknesses of brick courses, accompanied by a set of brick scales, which are a great assistance in enabling a draughtsman to work faster and more accurately, and most young draughtsmen do not always appreciate the cost value in getting out their work quickly. If the book and the scales do not happen to be a part of the office equipment, it would pay the young draughtsman to secure them for his own personal use.

In making the drawings for city buildings, the building line (that is, the boundary-line between the lot and the sidewalk) should be shown on all plans and sections, and all projections beyond the building line, and all setbacks from the building line should be figured with relation to the building line. Also, the sidewalk grades should

be given, and the grade of the finished first floor established with relation to these grades. These are simply a few of the many little things which the young draughtsman just starting out will have to learn, and although they may look trivial, and some of them are trivial, they will help to make the drawings more workable, and thereby make the work run more smoothly both in the office and on the job, and, incidentally, will make the young draughtsman more of an asset and less of a liability.

CHAPTER V

DRAUGHTSMEN AND READING

It is unfortunate but true that the great majority of young draughtsmen and technical-school graduates are poorly read. The fact was very forcibly brought home to the writer recently when in conversation with two young men who were recent graduates of technical schools he was surprised to learn that neither of them knew who Augustus St. Gaudens was, and yet both were ardent admirers of Stanford White, but had read so little that they did not know the name of the sculptor who collaborated so many times with White, and had been his friend and boon companion for so many years. Now, it is not the province of this short chapter to prescribe a reading course which is to make every draughtsman a well-read man. That is too big a problem and too difficult, and, be-

sides, President Eliot has already given us the "Five Foot Shelf." There are, of course, any amount of books that are valuable and the reading of which will help the young man, but time is also valuable, and the study of architecture is, in itself, a man-sized job. Still, the great necessity is to avoid one-sidedness and to acquire a general knowledge, most particularly a knowledge of the history of architecture and the allied arts; also to gain the critical and analytical view which will enable them to judge the arts with which they are associated.

Probably one of the best methods of assimilating the history of art and architecture is the study of general history—to learn of the times when art and artists lived. The young man who knows the history of Greece, Rome, and Byzantium is far better able to appreciate the history of the art and architecture of those countries than one who merely knows the five orders and the countries in which they had their origin. One who has read the history

of the Middle Ages and the Renaissance will appreciate Gothic and Renaissance architecture far more than one who merely knows the styles, and knows nothing of the life and times that gave them birth.

There are a few books, however, which will help wonderfully to broaden the view and enrich the mind of the young draughtsman, and which are not so dull and dry that the reading of them is a task and must be taken up as so much labor toward a given end, as much of what is studied in the schools amounts to. One of the most instructive and interesting books dealing with art, more particularly with painting but applicable to all of the arts, is Sir Joshua Reynolds's "Fifteen Discourses," easily read in fifteen hours, and very well worth the effort. Mr. Whistler's "Ten o' Clock" can be easily read in less than an hour, and it will be an hour well spent.

To gain an insight into the art life in Italy in the sixteenth century there is no book better than the "Memoirs of Benvenuto Cellini," after which one should

read Symonds's "History of the Renaissance." To learn of the life and history of the Middle Ages and the art and philosophy of that period there is perhaps no book which gives a better and clearer insight into the spirit of those times than Henry Adams's "Mont St. Michel and Chartres." "Mediæval Architecture," by A. Kingsley Porter, is without a doubt the most scholarly history of the architecture of that period. Ralph Adams Cram's "The Gothic Quest" and "The Substance of Gothic" are also both of them very excellent studies on the subject, and, like everything which Cram writes, they are very readable and very interesting.

The reader can learn much that is interesting and instructive of the art and artists of Italy from the thirteenth to the sixteenth century by reading the biographies of the greater and better-known artists in Vasari's "Lives of the Most Eminent Painters, Sculptors, and Architects," and omitting many of the lesser ones who are of no particular interest and whose

work is practically forgotten. Vasari, although often inaccurate and sometimes unfair, is interesting, and in practically all cases his estimate of the men and their work is correct. To properly enjoy Vasari the writer would advise the casual reader to avoid reading the footnotes, as they detract from the pleasure of reading the author's version, and are only valuable to those who are making a deep research on the subject. Kenyon Cox's "Concerning Painting" and "The Classic Point of View" are pleasant and instructive reading, and give a good critical analysis of that branch of art.

These few books are only a very small part of what has been written on art and architecture, but are suggested as they are not only instructive but interesting, and are a very good start in forming the habit of reading, which unfortunately seems to be rapidly becoming a lost art. It is unnecessary to say that with the specialized reading it is necessary to do some general reading as well, as an architect should be

a broad-minded, well-informed man, and every really brilliant architect whom the writer has ever known was a well-read man; and as draughtsmen are potential architects, draughtsmen to succeed must read, and read to remember and not read to forget.

APPENDIX

APPENDIX

The following formulæ will be of assistance in the writing of specifications.

CONCRETE

One part Portland cement.
Three parts sand.
Six parts broken stone or gravel.

May be used for foundations, footings, floors, etc.

One part Portland cement.
Two and one-half parts sand.
Five parts broken stone or gravel.

Where a strong concrete is desired, such as machinery foundations, etc.

CONCRETE FOR STEPS, SILLS, LINTELS, ETC.

One part Portland cement.
Two parts sand.
Two parts broken stone or gravel, which will pass over a $\frac{1}{2}''$ mesh, and through a $1''$ mesh.

FINISH FOR CONCRETE FLOORS, AND FACING FOR STEPS, SILLS, LINTELS, ETC.

One part Portland cement.
One part sand.
For best work.

One part Portland cement.
Two parts sand.
For cheaper work.

Note: Always specify that floor finish shall be applied while concrete is still wet.

Facing of sills, lintels, etc., to be applied before the body of the structure has taken its final set.

CEMENT MORTAR

One part Portland cement.
Three parts sand.
Five per cent hydrated lime or lime putty.

COMBINATION MORTAR

One part Portland cement.
One part hydrated lime or lime putty.
Six parts sand.

SETTING MORTAR FOR LIMESTONE

One part lime putty.
Three parts sand.
Ten per cent stainless cement.

POINTING MORTAR FOR LIMESTONE

One part stainless cement.
Two parts clean white sand.
Sufficient cold lime putty to make as stiff a mixture as can be worked.

CINDER FILL

One part Portland cement.
Two parts sand.
Ten parts clean steam cinders.

For filling between floor sleepers, and levelling up on floors, roofs, etc.

Note: Always specify cinders to be well washed, and to be free from sulphides, unburned coal, or ashes.

CEMENT PLASTER

One part Portland cement.
Two parts sand.
One-tenth part hydrated lime.

Mortar for first coat shall have a thorough intermixture of long cattle hair.

MATERIALS

PORTLAND CEMENT

Cement shall be a standard brand of American Portland cement, and shall conform to the requirements of the latest specifications adopted by the American Society for Testing Materials.

SAND

All sand shall be washed bank sand, and must be properly screened before mixing with the cement; it shall consist of clean, sharp, coarse grains, uniformly graded in size, the largest grain not to exceed $\frac{1}{4}''$ in diameter. It shall contain not more than five per cent of clay or loam, and shall be free from salt and all other impurities.

Sand for setting mortar for limestone, and for pointing, shall be a clean white sand, well washed, and free from vegetable matter, salt, or other impurities.

BROKEN STONE

Broken stone shall be a clean, hard, durable crushed granite, trap rock or flint limestone, to be free from clay, loam, or crusher dust. Stone shall be uniformly graded from $\frac{1}{4}''$ to $1\frac{1}{2}''$ its greatest diameter.

WHITEWASH

Formula of the United States Government, used largely in lighthouse work, etc.:

Slake one-half bushel of lime in boiling water, keeping it covered. Strain and add one peck of salt, dissolved in warm water, then boil to a thin paste. Add one-half pound of powdered Spanish whiting and one pound of clear glue dissolved in warm water, mix, and let the mixture stand for several hours.

Keep whitewash in a kettle or portable furnace, and apply as hot as possible, using a wide brush. Whitewash is improved by the addition of three pounds of powdered rice before boiling.

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